SCIENCE ABSTRACTS.

Section A.—PHYSICS.

FEBRUARY 1908.

GENERAL PHYSICS.

194. *Comparator.* **A. J. Cox.** (Zeitschr. Instrumentenk., Beib. 22. pp. 229–231, Nov. 15, 1907. Bureau of Science, Manila, Philippines.)—A new standard of weights and measures has been inaugurated in the Philippines, and the present paper describes, with plate, the comparator used for comparing scales with the new standard of length. A solid base carries two vertical guide-bars rigidly connected at the top by a cross-piece, from the middle of which the two scales to be compared are hung. The suspensions for both are provided with an adjusting screw, so that the scale zeros can be set together. The bottom of each scale is secured to the base by a suitable clip. The reading microscope (magnification = 60 diams.) has horizontal traverse on the edge of a plate (capable of adjustment) which is carried on a slide having vertical motion on the guide-bars. The weight of slide and microscope is balanced by two compensating weights attached to cords passing over pulleys fixed on the head of the apparatus. With the aid of a scale in the eyepiece of the microscope readings can easily be obtained correct to 0·01 mm. For greater accuracy the more costly method of the (German) Imperial Commission of Standards is recommended [Zeitschr. Instrumentenk. 15. pp. 318–358, 1895, and Phys. Soc. Abstracts, No. 701 (1895).] A. W.

195. *Measurement of the Extension of Test-pieces under Tensile Stress.* **W. J. Lambert.** (Inst. Civ. Engin., Proc. 169. pp. 349–351, 1906–1907.)—Two knife-edges are fastened to the specimen so as to lie immediately opposite each other in the same plane. The image of the gap produced by the separation of these knife-edges is magnified 100 diams. and is projected by means of a photomicrographic apparatus on to a screen, where its width is measured accurately by means of a sliding vernier. This apparatus, designed for determining the modulus of elasticity, will measure extensions to 0·0001 in. F. C. A. H. L.

196. *Conical Punch Hardness Test Number, and Elastic Limit of Steel.* **A. Leon.** (Stahl u. Eisen, 27. pp. 1820–1823, Dec. 11, 1907.)—Refers to a paper by P. Ludwik (Zeitschr. des Oesterr. Ing. u. Architekten Vereins, 11 and 12, 1907; Baumaterialienkunde, Nos. 8 to 10, 1907) in which the use

of a conically pointed punch is advocated in hardness tests otherwise similar to Brinell's, in which a ball is used. The advantages claimed by Ludwik are that as the impressions are always similar figures, the hardness-number is constant for all loads with a given material, and that the depth of the impression can be measured during the test—a less troublesome matter than having to measure the diam. specially after making the depression. The author gives the results which he has obtained by the method upon five steels ranging from 0·08 to 1·18 per cent. carbon. The variability of the Brinell-number with different loads is illustrated, and the chief conclusion is that the hardness-numbers in the conical punch test appear to be closely related to the elastic limit. Averages are given in the following table, the Brinell-numbers being obtained with a load of 3,000 kg. :—

Carbon, per cent.	Elastic Limit, kg./cm.².	Tensile Strength, kg./cm.².	Elongation, per cent.	Brinell-Number.	Conical Punch Test Number.
0·08	2,477	4,200	32	121	130
0·20	2,658	4,288	29	121	140
0·52	3,620	6,595	21	179	195
0·77	4,625	8,890	4·3	255	290
1·18	5,970	8,867	2·1	277	330

F. R.

197. *Reinforced Concrete.* **E. Probst.** (Königl. Materialprüfungsamt, Mitt. 1. pp. 1–144, 1907.)—Gives in detail the results of tests of plain and reinforced concrete beams. The data regarding the strength of the beams with different types of reinforcement, and different concrete mixtures, do not admit of useful abstraction. The position of the neutral axis was in all cases on the reinforced side of the central plane in the earlier stages of the loading, gradually passing over to the opposite side as the loading increased. The total extension of reinforced concrete is greater than that of plain concrete. The total extension of specimens is greater if kept moist than if kept dry. The extension is more evenly distributed along the beam if the reinforcement be not polished before embedding. The extension of the concrete at the moment of the appearance of cracks is no more if reinforced than if plain. The corresponding load may be higher, however, in the reinforced beam. Experiments in which the beams were exposed to an atmosphere of CO_2, oxygen, and water-vapour for considerable periods whilst under load, show that until the load is such as to stress the reinforcement to its elastic limit there is no rusting of the bars. As shown in the tests of beams, the adhesion between concrete and steel is diminished at the moment the max. stress which the concrete can support is applied to it. The adhesion depends on the condition of the surface of the metal. The greater the adhesion, the higher the breaking load. The older the beam the greater the adhesion. The rules pertaining to the design of ferro-concrete in several countries are discussed and applied in the consideration of the experimental results. The paper is amply illustrated. F. R.

198. *Pressure Loss in Water Pipes.* **A. W. Brightmore.** (Inst. Civ. Engin., Proc. 169. pp. 315–336, 1906–1907.)—The paper gives a description of experiments carried out on a large scale at the Royal Indian Engineering

College. A tank of 14,000 galls. capacity was mounted on braced steel columns so that its top water-level was 50 ft. above the floor of the laboratory, a similar tank being placed beneath the floor. The pipes used in the investigation were 3 in., 4 in. and 6 in. diam., and each range of pipes was 50 ft. in length. For further experimental details see original paper. The results obtained for the loss of head along straight pipes show that the allowance made by Rankine's form of the Darcy formula for the discharge coefficient c, namely, $c = \text{const.}/\sqrt{1 + 1/12d}$, does not give a sufficient reduction for pipes of smaller diam. when rusted but not tubercled. The author's results for c were, for pipe diams. of 3, 4, and 6 in. respectively, 41·8, 47·5, 50·6 ; and from these the following formula has been obtained : $v = [56/(1 + 1/40d^2)] \sqrt{di}$, d being the diam. of the pipe in ft., i the loss of head per unit length, and v the velocity in ft. per sec. For large pipes the formula agrees with Darcy's values, which have been confirmed by numerous experimenters. Experiments were also undertaken to determine the loss of head at sudden contractions and enlargements, and also that due to bends. It was found that the actual loss of head at contractions and enlargements shows close agreement with the theoretical values, particularly for a ratio of the areas as great as 4 to 1. With regard to bends, on which numerous experiments were made, the author found (i.) that the additional loss of head in right-angled elbows on pipes of 3 in. or 4 in. diam., due to the deflection of the current through a right angle, is the same at identical velocities ; (ii.) that the additional loss of head in right-angled bend pipes of these diameters has a minimum value for bends of a radius equal to 4 diams., irrespective of the velocity of flow ; (iii.) that the additional loss of head in pipes of these diams. attains a maximum for a radius of bend of 6 or 7 diams., and falls again for bends of greater radius ; (iv.) that the loss of head in right-angled bends of a radius giving the minimum loss is independent of the size of the pipe, and depends only on the velocity of flow and the condition of the internal surface of the pipe ; (v.) that the additional loss of head in the case of short bends occurs in the length of pipe following the bend, owing to the intensified eddying-motion there, due to the rearrangement of velocities ; (vi.) that in the bends experimented upon, the flow tends to approximate to a "free" vortex, the pressure being greatest at the outside and least at the inside of the bend ; (vii.) the last conclusion is confirmed by the fact that the velocity was found to be a maximum at the inside of the bend and a minimum at the outside, their relative values being approximately inversely proportional to the radii. A. W.

199. *Elementary Quantity of Energy.* **J. Stark.** (Phys. Zeitschr. 8, pp. 881–884, Dec. 1, 1907.)—The principle of relativity formulated by Lorentz [Abstract No. 1481 (1904)] and Einstein [Abstract No. 2277 (1905)] has been combined by Planck [Abstract No. 1480 (1907)] with the principle of least action. Planck concludes that the mass M_0 of a body referred to the translational velocity $v = 0$, equals the internal energy E_0 of a body divided by the square of the velocity of light c, viz., $M_0 = E_0/c^2 \ldots (1)$. The mass of the electron at rest is $5{\cdot}65 \times 10^{-28}$ gm. Its energy is $e_0 = m_0 \times c^2 = 5{\cdot}08 \times 10^{-7}$ erg. The author proposes to call this energy the elementary quantity of energy. In the region of space and time covered by human experience e_0 is indivisible and unchangeable. It is the smallest quantity of energy attached to an electron or to a material body, and may therefore be styled the "atom of energy." In accordance with the principle of relativity, the total energy of the moving electron may be put equal to $e = e_0 (1 - v^2/c^2)^{-\frac{1}{2}}$. The longitudinal mass of the electron in steady motion is $m = m_0(1 - v^2/c^2)^{-\frac{1}{2}}$. Its kinetic energy is $m_0v^2/2$ as a first approximation, which equals $(e_0c^2)\,v^2/2$. If Planck's law of radiation is correct, the formula connecting the smallest quantity of oscillatory energy ϵ with the frequency of a resonator and the universal constant of radiation h_0 is $\epsilon = h_0n = e_0n/n_0$. The quantity n_0 is a frequency, and its reciprocal $T_0 = 1/n_0$ is a time. This T_0 is another universal constant attached to the electron. If $n_0 = 6·55 \times 10^{-27}$ erg per sec., this "elementary quantity of time" is $1·28 \times 10^{-20}$ sec., and the elementary frequency is $7·76 \times 10^{19}$ per sec. The Zeeman phenomenon and the phenomena of dispersion, taken in conjunction with Planck's law of radiation, suggest the existence of a single electric elementary resonating body, the (negative) electron. This justifies us in ascribing to it the elementary time T_0, which implies an elementary angular velocity $w_0 = 2\pi/T_0$, and suggests that the electron is the centre of a cyclic motion. The author supposes that this cyclic motion has two axes, a circular one and a rectilinear one normal and central to the circular one. To arrive at the positive atom, the author arranges a number of electrons in a circle so that their axes are tangents to it, and endows the ring thus formed with a high speed about its centre. He assumes an hypothetical central force which gives stability to the ring, and that the vector field is again represented by a cyclic motion about a linear and a circular axis. But then their directions are opposed to those of the negative electron, and we obtain what may be called the model of positive electricity. This may be compensated by electrons placed at its centre, and these would be the electrons liberated in the process of ionisation, whereas the β-rays of radio-active bodies are constituents of the ring. Since the chemical atoms possess, by (1), internal energy, its amount may be calculated from the mass. That of a hydrogen atom is $1·08 \times 10^{-3}$ erg, a very large amount. A large drain on this energy would annihilate some of the mass. If more complex atoms are constituted from elementary rings, and this combination consumes energy, it may be taken for granted that the atomic weights will deviate from simple multiples more and more as they increase. Putting e_0, T_0, and c all equal to unity, we obtain for the unit of length $8·84 \times 10^{-10}$ cm., and for the unit of mass $5·65 \times 10^{-28}$ gm., which are also associated with the electron. The author proposes to call this new system of units the "atomistic" system.

E. E. F.

200. *Ether and Gravitation.* **C. Barus.** (Science, 26. p. 875, Dec. 20, 1907.)—If a body rotates in a fluid lighter than itself, it must, in virtue of centrifugal force and the principle of Archimedes, sink towards the centre of rotation. Assuming Lodge's value of the density of ether, 10^{12}, to be correct, a very slight rotation of the ether would suffice to account for gravitation. If the angular velocity of the ether were but one-millionth that of the earth about the sun, there would be no centrifugal force to compensate gravitation. On the whole, however, a fixed ether is the only satisfactory inference.

E. E. F.

201. *Actual Air-pressure Periods of Many Days.* **E. Herrmann.** (Phys. Zeitschr. 8. pp. 874–879, Nov. 15, 1907. Paper read before the 79. Naturforscherversamml., Dresden.)—Considering the distinction between cyclones and anti-cyclones, and also Maury's zones and Ferrel's circulation as meteorologically useless, the author draws attention to stationary oscillations and progressive waves in the air-pressure. He illustrates his views by referring to the barometric curves, covering several years, of Deerness, Bodö, Nantes, and Neufahrwasser. In these curves he finds the several lunar periods and also the solar day period, into which he now is inclined to resolve the period of several years which he had previously suggested. Reference is made to Margules, to Exner [see Abstract No. 17 (1908)], and to the so-far unpublished researches of J. Schneider concerning the influence of the moon on the wind components at Hamburg. H. B.

202. *Omori's Report on the Great Indian Earthquake of April 4, 1905.* **C. F. Marvin.** (Publications of the Earthquake Investigation Committee of Japan in Foreign Languages, Nos. 23 and 24. Monthly Weather Rev. 35. pp. 361–368, Aug., 1907. Abstract.)—The epifocal zone formed an elongated tract extending north-west and south-east for about 170 miles, approximately parallel to the trend of the sub-Himalayan chains of the Punjaub. No great surface faulting nor dislocation of the ground seems to have occurred, and the origin must therefore have been deep below the surface (not more than 20 or 30 miles, however, in Marvin's opinion). The mud or rubble masonry houses of the district, surmounted by heavy slate roofs, are unsuited to withstand seismic action which proper wooden or steel-frame structures would resist. The maximum acceleration of the vibratory motions of the ground was 3,500 mm./sec.^{2} at Kangra, and smaller at the other spots, while it had exceeded 4,000 mm. in the Mino-Owari plain during the Japan earthquake of 1891, and was probably 2,600 mm. at the San Francisco earthquake. Omori distinguishes the W_1 motion over the short minor arc of the great circle passing through the station and the origin, from W_2, the motion over the major arc; W_3 is the W_1 which after passing the station ultimately returns after circumnavigating the globe. W_2 and W_3 are generally superposed on the end-portion or "tail" of the record. The transit velocities are estimated by the direct method (and by the difference method): W_1—first preliminary tremor 10·52 (11·36) km./sec.; second preliminary tremor 5·68 (6·46); first phase, principal portion 4·07 (4·70); third phase, principal portion 3·11 (3·28); W_2—commencement 3·75; first maximum 3·54; principal maximum 3·34 (3·39); W_3—principal maximum 3·40 (3·40) km./sec. Discussing the formulæ for the distance of origin (x in km.) from the duration (y sec.) of the first preliminary tremors of various earthquakes, Omori arrives at the general formula for distances of 20° to 140°: $x = 14·28y - 890$. The weight of the bob of the horizontal pendulum should not be too great, the strut (horizontal distance between point of support and steady axis) should be long, the height of the pendulum large. H. B.

203. *Origin of Bands in Sun-spot Spectra.* **A. Fowler.** (Roy. Astronom. Soc., Monthly Notices, 67. pp. 530–534, June, 1907.)—Most observers of sun-spot spectra have noticed peculiar band-like structures in various regions, which have not hitherto been traced to their source. These are now ascribed to a compound of magnesium and hydrogen in the spot umbræ. The brightest of these bands or flutings begins in the green near λ5211, and fades off towards the violet; others are near 5620 and 4860. After obtaining a photograph of the 5211 fluting with a spectrograph of large dispersion there could be little doubt of its identity with the banded structure seen in the spectrum of the spot umbra, and a list of the measured wave-lengths is given for comparison. The identification is of interest as supporting the view that the vapours in spots are at a relatively low temperature. Also, as a great number of the umbra lines thus identified were found by Hale to

correspond with very faint solar lines tabulated by Rowland, it must be inferred that magnesium hydride not only occurs in spots, but in a less degree in the general reversing-layer of the sun. C. P. B.

204. *Weakened and Obliterated Lines in Sun-spot Spectrum.* **G. Nagaraja.** (Astrophys. Journ. 26. pp. 148–154, Oct., 1907.)—Until recently the examination of sun-spot spectra has been mainly directed to those lines which are more conspicuous in the spot spectrum, but the work of Mitchell, Hale and Adams, and Fowler has shown the presence of another type of effect, in which the Fraunhofer lines are weakened in the spot, and even at times quite obliterated. [See Abstracts Nos. 2027 (1905); 490, 2000 and 2001 (1906).] Using a concave parabolic grating with the polar heliostat spectrograph of the Kodaikánal Observatory, South India, the author has obtained excellent photographs of the spot spectrum between D and F, with a linear dispersion of about 1·45 tenth-metres per mm. In this region about 167 lines have been found which are either thinned, weakened or obliterated, being about half the number of widened lines in the same region. Most of these lines are also well shown in the map of sun-spot spectra circulated by Hale, representing the constitution of spots during the latter part of 1905, so that there has been no noticeable variation of the weakened lines in the spectra of sun-spots during this interval. From a summary of the observations it is seen that "unknown" lines and iron lines are represented in large numbers, while the nickel and silicon lines are generally weakened, and those of titanium and chromium are chiefly widened. With regard to the enchanced lines, although it cannot be said that most of the weakened lines in spots are spark lines, we see that the majority of spark lines are weakened. Moreover, almost all the titanium and chromium lines weakened in spots are spark lines.

C. P. B.

205. *Ultra-violet Region in Sun-spot Spectra.* **J. Evershed.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 12–15, Nov., 1907.)—Recent photographs of sun-spot spectra under improved instrumental and atmospheric conditions have shown that there are numerous affected lines in the ultra-violet region similar to those usually seen in the blue, green, yellow, and red parts. Owing to the intrinsic darkness of the umbra, longer exposures had to be given for the spot spectra than for the adjoining Fraunhoferic spectra, in order to equalise their intensities. A table is given showing the wave-lengths and intensities of the affected lines, from which it is to be noted that, as in the visible region, the lines of titanium and vanadium are among those most strengthened, while of the seven affected iron lines six are weakened in the spot spectrum. The hydrogen lines γ and δ are weakened, both in width and intensity. C. P. B.

206. *Cyanogen in the Solar Atmosphere.* **H. F. Newall.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 2–11, Nov., 1907.)—Observations made by various observers have shown that the fluting near $\lambda 3883$ in the solar spectrum is due to cyanogen, and the bands due to this substance were recognised with certainty in the spectra of the chromosphere photographed at the total solar eclipses in India (1898) and Sumatra (1901). The present experiments were undertaken with the intention of finding whether the cyanogen also existed in interplanetary space. The presence of the cyanogen as part of the solar atmosphere is easily demonstrated by taking two comparison photographs of the light from the east and west limbs respectively, when all the truly solar lines are seen to be displaced with respect to each other, while the lines due to the absorption of our own atmosphere are not so displaced. Superposed on these, however, the author finds a trace of cyanogen bands which exhibit displacements of a different order, and also show a strange duplication at the east limb only. This special feature was found to be variable in amount during Sept., 1907 and attention is drawn to the fact of the earth having about that time passed through the position occupied by Comet Daniel about July 27. C. P. B.

207. *Spectroscopic Observations of the Sun's Rotation.* **W. S. Adams.** (Astrophys. Journ. 26. pp. 203–224, Nov., 1907. Contribution from the Solar Observatory, No. 20.)—The spectroscopic study of the sun's rotation has hitherto been confined to visual measures of lines in the less refrangible part of the spectrum, and the present investigation was undertaken with the powerful spectrograph at the Mount Wilson Solar Observatory to examine the problem photographically. The spectrograph is of the Littrow type, having a lens 4 in. (10·2 cm.) in diam. and 18 ft. (5·5 m.) focal length, employed in conjunction with a plane Rowland grating ruled with 14,438 lines to the inch (570 lines to the mm.), the fourth order being generally used. The linear scale is such that at λ4200 1 mm. = 0·71 A.U. The solar image on the slit plate is 6·7 in. (17·0 cm.) diam., and is given by a large concave mirror of about 60 ft. focal length. Two sets of rectangular prisms, adjustable radially with respect to the image, can be set to any desired position angle, so that the light from near the opposite limbs of the sun may be brought into juxtaposition on the slit plate for comparison. The velocities are then determined from the displacements of the spectrum lines measured on the photograph. A curve is given showing the variation in rotation period with solar latitude, as follows :—

ϕ.	Period in Days.	ϕ.	Period in Days.
0·2°	24·89	44·7°	28·19
7·7	24·83	52·7	29·15
15·0	25·01	59·6	29·68
22·7	25·86	65·7	30·02
29·7	26·32	74·9	30·38
37·7	27·46	80·4	30·40

For the interval under discussion, about 14 months, there was no indication of variation of the rotation period. C. P. B.

208. *Surface Temperature of the Sun.* **J. M. Schaeberle.** (Science, 26. pp. 718–719, Nov. 22, 1907.)—Working with a reflecting telescope of very great angular aperture (diam. 2 ft., focal length 3 ft.), the surface temperature of the sun is given as about 20,000° C., according to the author's value of temperature for a small black particle, and about 12,000,000° C., taking Poynting's value. [See also next Abstract]. C. P. B.

209. *Sun's Temperature.* **J. M. Schaeberle.** (Science, 26. pp. 877–878, Dec. 20, 1907. Extract.)—Mainly because of the very high, and for certain reasons inadmissible, temperature heretofore obtained when Newton's law of radiation is employed, astronomers and physicists hold that this law cannot be used for determining the effective surface temperature of the sun. The author of the present paper maintains, however, that this law is as valid as that of gravitation, and is the only one by which the sun's surface temperature can be determined. From his observations on the absolute temperature of space he thus obtains a value for the sun's temperature. His results are as shown in the table:—

	Uncorrected.	Corrected for Atmosphere.
Absolute temperature of space	0·7° C.	1·5° C.
Effective surface temperature of sun ...	30,800° C.	66,000° C.

[See also preceding Abstract.] E. H. B.

210. *Inequalities in the Motion of the Moon.* (Nature, 77. pp. 43–44, Nov. 14, 1907.)—The article is a short review of Newcomb's latest work on his investigation of the inequalities in the motion of the moon produced by the action of the planets. The most interesting result is that he has found 1·14″ as the theoretical coefficient of the Jupiter evection term, which was originally discovered by Newcomb in 1876. Two or three years ago it was pointed out that the observations indicated a value of about this order, so the confirmation of theory is very welcome. The method of evaluating the Jupiter evection term is given. C. P. B.

211. *Condensations on Saturn's Rings.* **P. Lowell.** (Astronom. Nachr., No. 4216. p. 267, Nov. 26, 1907. Nature, 77. p. 116, Dec. 5, 1907.)—Telegram from Lowell saying that the reported condensations on Saturn's rings were confirmed and had been measured repeatedly. They were visible, symmetric and apparent. The outer was situated near the outer edge of ansa *b*, and the inner at the middle of ansa *c*. C. P. B.

212. *Saturn's Tores.* **P. Lowell.** (Scientific American, 97. pp. 441–442, Dec. 14, 1907.)—The author's recent observations of Saturn at Flagstaff have led him to take the view "that certain parts of the ring system are not flat, but of the nature of tores, a tore being a sort of flattened anchor ring" [?]. One such tore he believes to lie in the outer portion of the "B" ring, and another in the outer portion of the "C," or crape, ring, the latter being much the broader of the two. On June 19, 1907, and on later occasions, when the ring was nearly edge-on to the earth, he observed its shadow on the ball of Saturn as a narrow dusky band 0·46″ in breadth, threaded centrally by a very fine black line 0·10″ wide. The band was too wide to be either the penumbra of the black line, or the shadow of the whole ring regarded as plane which would only measure 0·26″ across. The author therefore concludes that the central dark line was the shadow of the plane portion of the ring system, and that, judging from the width, it was probably the "A" ring which was here concerned. The dusky fringe he regards as the shadow of parts of the ring system outside the general plane. As regards the appearances presented by the rings themselves, for the most part they showed only as the finest of lines of light stretched on either side of the disc like golden threads, but at four places, situated symmetrically two and two at either side, bright star-like beads were visible, at distances 1·10–1·46 and 1·72–1·92, in radii of Saturn, from the planet's centre. Such phenomena have been observed before, and are usually accounted for as places where the sum of the breadths of the

various rings in the direction of vision is greatest. The author states, however, that this would put the maxima where the minima fall, and *vice versâ*, and he regards the bright beads as evidence of the existence of tores. The presence of such tores in the ring system he attributes to a tossing of particles out of their original level by collisions due to satellite action. Since each collision would entail loss of *vis viva*, such an effect would be most pronounced just inside the zones of greatest perturbation. The regions where the perturbing effect is greatest is where the periods of disturbed and disturber are in the ratios 1 to 2, 1 to 3, and 1 to 4. In the case of Mimas this occurs at Cassini's division, at the boundary of rings B and C, and at about two-thirds in along ring C. In the course of the article the author mentions that measures just made at Flagstaff show that the crape ring extends nearly 4,000 miles farther in than hitherto supposed, continuing to within about 3,400 miles from the planet's surface. A. E.

213. *Observations of Disappearances of Saturn's Ring, made at Lyons.* **J. Guillaume.** (Comptes Rendus, 145. pp. 1254–1256, Dec. 16, 1907.)—The plane of Saturn's ring passed through the earth on April 12 and Oct. 4, and through the sun's centre on July 24, 1907. The author did not observe the April disappearance, the planet being then unfavourably situated. Cloudy skies prevented observations on the exact date of the July phenomenon, but the October disappearance could be followed satisfactorily. The nearest times of observation are the following: 1907, July 22, 15h. 33m. Paris mean time, ring invisible; July 27, 13h. 42m., ring visible; Oct. 2, 7h. 5m., ring visible; Oct. 3, 6h. 20m., ring invisible. The appearances in July and Oct. were very different. After the phase of invisibility in July the ring was feebly illuminated, and for several days had a nebulous aspect, with a ruddy tinge, like that of the moon during eclipse, which persisted for some time. It next assumed a granular appearance, some of the grains seeming brighter than others. Then, as the sun's elevation increased, the ring gradually became as bright as the ball of the planet. Corresponding appearances in inverse order might have been expected to precede the October disappearance, but nothing of the kind was seen. The author suspected he saw the ring a day or two after disappearance was recorded. The ansæ were sometimes noted to be of unequal brightness, the western being the brighter. The southern hemisphere of the planet was always darker than the northern. Some rather rapid changes were witnessed on the latter, but the most striking feature of the ball was the white equatorial belt, upon which the ring or its shadow could sometimes be seen in projection, the ring appearing brownish grey, the shadow black. When the ring was invisible on July 22 and Oct. 3 its shadow could be seen on the ball as a very fine black line. A. E.

214. *Relation between Star Colours and Spectra.* **W. S. Franks.** (Roy. Astronom. Soc., Monthly Notices, 67. pp. 539–542, June, 1907.)—The colours of the stars used in the investigation are taken from observations by members of the British Astronomical Assoc., and the spectra from Harvard Annals. The selected stars include 928 of the brighter ones in the Northern Hemisphere and 432 in the Southern. The various Harvard classes of spectra are grouped into seven divisions comprising stars of the following types respectively: Hydrogen stars, Helium stars, α Carinæ, Solar, Arcturus, Aldebaran, and Betelgeuse types. Twelve different colour headings are adopted, ranging from white, through various intermediate shades and mixtures of yellow and

orange, to red. The numbers of stars of each colour are tabulated for each of the seven spectral divisions. Of the total number, 58·3 per cent. are white, or nearly so, 29·1 pale yellow or pale orange, 11·8 (full) yellow or orange, and 0·8 ruddy. On the whole the author concludes that there is a striking agreement between the colours and spectra. The majority, both of the helium and hydrogen stars, are white, the proportion being equal in the two classes. In the α Carinæ group the typical tint is yellowish white; in solar stars it is pale yellow; in the Arcturus type between pale orange-yellow and yellow; in the Aldebaran type there are two maxima, at orange-yellow and orange. The distribution of tint in stars of the Betelgeuse and Aldebaran types is very similar, and it would be difficult by mere eye observation to tell to which of the two a star belonged, though the spectra are essentially different. The author remarks on the curious affinity shown by helium stars (B class) and bright-line spectra (O class) for the Galaxy. Some of the latter are associated with nebulæ. All the bright-line spectra met with in the investigation were in or near the Milky Way, as are all the Wolf-Rayet stars, all the Novæ, and the majority of short-period variables. A. E.

215. *Inclination of Binary Star Orbits to the Galaxy.* **T. Lewis** and **H. H. Turner.** (Roy. Astronom. Soc., Monthly Notices, 67. pp. 498–508, June, 1907.)—It having been suggested that the axis of rotation of variable stars tends to be parallel to the Galaxy, it was thought of interest to examine the elements of double stars to see if they also revolve in a corresponding manner. A list of 59 orbits is given, and from a discussion of these it is concluded that orbits nearly at right angles to the line of sight seem to avoid the Galactic Poles, as has been noticed to be the case with stars which present their poles to us. The distribution of spurious poles of double stars is next examined, with the result that at least 75 per cent. are scattered uniformly over the celestial sphere. C. P. B.

216. *Spectrum of Mira Ceti.* **W. Sidgreaves** and **A. L. Cortie.** (Roy. Astronom. Soc., Monthly Notices, 67. pp. 534–538, June, 1907.)—Photographs of the spectrum of Mira were obtained at the Stonyhurst Observatory during the maximum of Dec., 1906. The line absorption spectrum was substantially the same as in 1897 and 1898, but the bands were very much weaker. Remarkable changes were noted in the radiation lines, especially that of H_β (hydrogen F). The hydrogen lines show an asymmetrical widening towards the red side, which on close examination is thought to confirm Campbell's observations of the triple structure in these lines. Visually the star on Dec. 6 was decidedly of a golden hue, being redder than Aldebaran when directly compared with it. If thus we assume that the increased brilliancy of the star at maximum is due to temperature, it is important to notice that the extension of the spectrum into the violet is also accompanied by a much greater radiative power in the red and orange part of the spectrum.

C. P. B.

217. *Distribution of Sulphur in the Hotter Stars.* **N. Lockyer.** (Roy. Soc., Proc. Ser. A. 80. pp. 50–56, Dec. 9, 1907.)—In the spectrum of β Orionis (Rigel) an isolated, clearly defined line was found at λ 4815·7, which had not been observed in any stellar spectra previously examined. This was so near the position of one of the strong sulphur lines that special photographs of the sulphur spectrum were taken, and the lines found compared again with the stellar spectrum. It was then seen that the characteristic group of sulphur

lines extending from λ4142 to λ4175 was decidedly present in the spectrum of Rigel, and other lines were subsequently traced in other regions, leaving no doubt as to the reality of the comparison. Tables of the lines and a reproduction of the Rigel spectrum showing the chief sulphur lines are given in the paper. [See Abstract No. 1063 (1904).] C. P. B.

218. *Structure of the Owl Nebula.* **E. E. Barnard.** (Roy. Astronom. Soc., Monthly Notices, 67. pp. 543–550, June, 1907.)—Comparison of the features of the Owl nebula, M. 97, as seen with the 72-in. Parsonstown reflector by Rosse, and the 40-in. refractor at Yerkes Observatory by Barnard. Two stars are seen projected on the mass of the nebula, and the recent observations show them to be in a different relative position than is indicated by the old records of 1848. Whether this may be explained by rotation of the nebula is still uncertain. C. P. B.

219. *Observations of Comet Daniel* 1907*d, and Scheme for the Complete Physical Study of Comets.* **H. Deslandres.** (Comptes Rendus, 145. pp. 843–848, Nov. 18, 1907.)—On photographs of the spectrum of Comet Daniel taken with a prismatic camera at Meudon it was found that, while the head gave a spectrum of the usual cometary type, the spectrum of the tail was peculiar, and differed from that of the head. It contained three lines or bands of indeterminate origin, two in the blue and one in the violet [see Abstract No. 1803 (1907)]. Two of these lines were found to have approximately the position of special hydrogen lines discovered by Pickering in stars of the ζ Puppis type. The Meudon discovery was to a certain extent confirmed by an announcement from Göttingen stating that, on photographs taken there, some lines due to the comet's tail, and not corresponding to the most intense bands of the head, had been found to be elongated. Later news from Nice entirely corroborated the Meudon results. Working also with a prismatic camera, Chrétien obtained photographs clearly showing the three lines in the tail mentioned above. The lines, however, appeared double. This difference may be due to the Nice apparatus being of considerably larger dimensions than the Meudon, or else to the fact that the observations were made on different days. The writer, however, suggests that the doubling observed at Nice may be explained simply on the supposition of three strictly monochromatic images having each a black central ray, such as is often found in ordinary images of the tail. This black ray is generally believed to be caused by the nucleus acting as a screen against the repulsive force emanating from the sun. The black ray does not appear in an image taken on the same day at Nice with an ordinary camera; but its absence may be due to length of exposure, or to superposition of the image of the luminous particles of the tail which would disappear in the spectrum. It is impossible to settle the question with the prismatic camera alone. An ordinary slit spectrograph would be required. Unfortunately the slit spectrographs at command were not sufficiently powerful, and thus an opportunity to solve an interesting problem was missed owing to insufficiency of methods and apparatus. The author suggests that an association, after the model of the International Union for Solar Research, should be formed for the study of cometary spectra, observatories nearly equally distributed in longitude co-operating in the work of research. Observations of position, being already well provided for, are not included in the scheme. The necessary instruments would also be useful for nebular investigations, and need not therefore stand idle in the intervals between cometary visits. The author's proposed programme of equipment includes the following apparatus: (1) For form registration, powerful cameras of both long and short focus. (2) For spectral study, both prismatic cameras and slit spectrographs of as large as possible dimensions, and high light-grasping power. They should be capable of revolution about the line of sight. (3) Ordinary cameras of large aperture-ratio, furnished with coloured screens for stopping out the gaseous radiations of the tail. The image obtained would thus be solely due to the luminous particles of the comet, and would enable the relative distribution of particles and gaseous matter to be recognised. (4) Ordinary cameras, also of large aperture-ratio, furnished with doubly refracting prisms for determining the proportion of light polarised. A. E.

220. *Spectrum of Comet Daniel,* **1907*d*.** **J. Evershed.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 16–18, Nov., 1907.)—The comet spectrum was photographed at the Kodaikánal Observatory during Aug. and Sept., 1907, with a short-focus objective prism spectrograph. Two very bright lines were seen in the spectrum of the nucleus, having approximate wave-lengths 3871·5 and 3883·5. There were numerous lines in the spectrum of the tail, at wave-lengths, 358, 369, 378, 4015, 4129, 4200, 4215, 4260, 4360, 4553, 4682.

C. P. B.

221. *Spectra of Two Meteors.* **S. Blajko.** (Astrophys. Journ. 26. pp. 341–348, Dec., 1907.)—Working at the Moscow Observatory, the author employed a prismatic camera consisting of a Voigtländer euryscope lens of 50 mm. aperture and 300 mm. focal length, with an attached prism having a refracting angle of 45°. The first exposure was obtained on May 11, 1904, and several stellar spectra were recorded on the plate; the wave-lengths of the hydrogen lines serving as fiducial lines from which to determine those of the lines in the meteor spectrum. The second exposure was made on Aug. 12, 1904, with the camera directed towards the Perseid radiant. Tables are given showing the provisional wave-lengths of the lines recorded.

C. P. B.

REFERENCES.

222. *Vibrations of Large Amplitude in a Resisting Medium.* **H. Zimmermann.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 50. pp. 874–907, 1907.)—A theoretical investigation of damped pendulum vibrations of large amplitude. After referring to the work of Frank [Abstract No. 926 (1905)] and of Hergesell, it is shown that the method of large vibrations leads in a simple manner to more exact results than that of small vibrations. The question of rectilinear vibrations is also touched upon, with reference to the resistance encountered by an air balloon. G. E. A.

223. *Estimation of Sea-level.* **A. Schreiber.** (Phys. Zeitschr. 8. pp. 869–870, Nov. 15, 1907. Paper read before the 79. Naturforscherversamml., Dresden.)—Gives a description, with theory, of a method of determining sea-level from balloon observations by mechanical quadrature. A. W.

224. *Masses of Mars and Jupiter.* **G. Leveau.** (Comptes Rendus, 145. pp. 903–906, Nov. 25, 1907.)—A short prefatory note concerning a new discussion of the meridian observations of the minor planet Vesta from 1807–1904, which are to be employed for determining the perturbations produced by the planets Mars and Jupiter, and therefrom the masses of these two planets. C. P. B.

LIGHT.

225. *Range-finder giving Horizontal Distances.* **C. Pulfrich.** (Zeitschr. Instrumentenk. 27. pp. 329–340, Nov., 1907. Communication from the Optical Works of C. Zeiss.)—The horizontal axis of a theodolite is made to carry two parallel telescopes; and the angle is measured through which the instrument has to be turned about its vertical axis in order that each telescope may view in turn the distant point under observation. Modifications of the instrument are described, and one of these, which is illustrated, consists of a single telescope with its axis on the base-line and two mirrors or prisms placed at different points on this line to reflect parallel rays into the upper and lower halves of the telescope. Measurements made with this instrument are susceptible to an error of 0·4 per cent., and a series of observations made on a large building is given as an example of the practical use of the instrument. G. E. A.

226. *Gérard's Telemeter.* (Scientific American, 97. pp. 289–290, Oct. 26, 1907.)—The chief optical part of this instrument consists of two very flat prisms of angle 5/1000 which are first cut into circular shape and then perforated in the centre, forming two ring-shaped prisms. These are mounted in a flat cylindrical box which is in two parts, allowing an axial rotation of one prism on the other of 180°, so that the prisms, at one extreme, neutralise each other, and at the other form a prism of double angle. The rotation of the prisms on one another causes a displacement of the image seen through them relative to that seen through the central aperture, and when the telemeter is rotated to displace the image through its own height, a special scale round the case of the instrument registers the distance of the object. An eye-glass or telescope may be mounted on the telemeter. The instrument is designed for military use, and objects of known height, such as an infantryman, cavalryman, or telegraph pole, are used in estimating distances, the latter having an accuracy of about 1 per cent. G. E. A.

227. *Prism Astrolabe.* **Claude and Driencourt.** (Journ. de Physique, 6. pp. 950–979, Dec., 1907.)—Details of the adjustments and method of working of the prismatic telescope invented some time ago, for taking the place of a transit instrument under certain conditions, and the determination of geographical longitudes and latitudes and the positions of stars. It is not, however, designed usually for accurate azimuth determination. The working of the instrument consists in observing stars whenever they attain a certain fixed altitude, the degree of which is settled by the angle of the prism attached to the objective, usually 60°. In principle the system works exactly like a sextant set at a constant angle, the difference between the direct ray and the reflected ray from a mercury bath placed in the same azimuth being double the altitude of the object. The faces of the prism must be as perfect as possible, and in the instrument described, by Jobin of Paris, they are worked to an accuracy of one-quarter of a wave-length, and the angles are equal within about 2″. The probable error in altitude is given as ± 0·32″, using a magnifying power of 150. C. P. B.

228. *A Colour-screen Colour Meter.* **F. E. Ives.** (Frank. Inst., Journ. **164**. pp. 421–428, Dec., 1907.)—A modification of the diffraction colour meter previously described [Abstract No. 1498 (1907)]. The grating is replaced by three rectangular colour screens which transmit a pure red (C½D), a narrow and well-defined band in the green with maximum at λ517, and blue violet from F½G to B. There is also a revolving wheel of convex lenses which optically mixes these colours to the eye in the field of the instrument. For comparison purposes, a laterally placed clear aperture is provided. It is claimed that by means of this instrument every colour found in the arts and industries can be quickly and accurately matched, measured in terms of three definite spectrum hues, recorded by three numbers corresponding to the colours red, green, and blue, and reproduced at any time by setting the instrument to the recorded numbers and directing it to a background of standard white. G. E. A.

229. *Permanency of Photo-visual Lenses.* **W. J. S. Lockyer.** (Roy. Astronom. Soc., Monthly Notices, **68**. pp. 19–29, Nov., 1907.)—Attention is drawn to various forms of crystalline growth on the surfaces of the components of the recently introduced photo-visual triple lenses. The markings were usually found on the back lens, of light silicate crown glass, and to a less degree on the baryta light flint lens. It is concluded that the crystals are due to the atmospheric moisture penetrating the lens system and, owing to the high percentage of alkali in this particular type of glass, carbonates being formed. An addendum is written by H. Dennis Taylor, the designer of this type of lens, stating that the deposit on the front lens can be removed by mere dusting with a camel-hair brush, and that the crystalline growth on the back lens is easily removed by rubbing with a soft rag moistened with dilute sulphuric acid. The glass with high percentage of alkali is not used now, a boro-silicate crown being employed instead. C. P. B.

230. *Selective Reflection of Salts of Carbonic and other Oxygen Acids.* **L. B. Morse.** (Astrophys. Journ. **26**. pp. 225–248, Nov., 1907. Phœnix Physical Lab. Contributions, No. 11.)—This investigation had as its object an inquiry into the influence of the atomic weight of the base upon the position of the reflection bands of salts having the same acid radical. The results, in the main, have been anticipated by Coblentz in papers published several months previously. [See Abstract No. 1506 (1907), also Jahrbuch d. Radioakt. u. Elektrotonik, **4**. p. 182, 1907.] The latter author, in addition to the reflection bands of carbonates, also investigated the transmission and reflection bands of seven sulphates. The present investigation, however, extends further into the infra-red than that of any previous experimenter, and contains other new features of detail, including some inquiry into the *rôle* played by oxygen in the selective reflection. The following is a summary of the conclusions: (1) The reflection curves for all the carbonates examined show between 4 μ and 15 μ three, and only three, bands of marked reflection. (2) The bands fall into three separate and definite spectral regions, which are distinct from the regions where the salts of other acids, so far as known, show reflection maxima. (3) With few exceptions, an increase in the atomic weight of the base causes a shift of all three reflection maxima toward long waves by an amount roughly proportional to the change in atomic weight of the base. (4) No regular displacements traceable to the chemical group to which the base belonged were observed, nor does any simple relation appear between the wave-lengths of the three bands in carbonates. (5) Combining with the data on carbonates the scattered observations on nitrates, sulphates and silicates, the tentative hypothesis has been made that the oxygen atom is the one chiefly responsible for the marked reflection observed. A. E.

231. *Reflection of Polarised Light.* **C. T. Whitmell.** (Nature, 77. p. 108, Dec. 5, 1907.)—Attention is called to an error in Preston's "Theory of Light" (Art. 158), the same erroneous statement being made in Tait's Text-book on Light (Art. 271), and in his Encyclopædia Britannica article on this subject. Let the planes of two thin plates of ordinary glass, A and B, be parallel, so that light which has been completely plane-polarised by reflection from A falls at the polarising angle upon B. Preston states that this light will be wholly reflected from B, whilst Tait says that it will be reflected almost without loss, from B. But, representing by unity the intensity of the polarised beam incident upon B, then the intensity of the light reflected from B will be represented by about $\frac{3}{7}$ and this is so when account is taken of both surfaces of B. The remainder of the beam, about $\frac{4}{7}$, is transmitted. To reflect the whole of the incident beam an infinite number of plates would be required, and the glass would have to be perfectly transparent. J. J. S.

232. *Determination of the Principal Indices of Refraction of a Crystal by means of the Plane of Polarisation.* **C. Viola.** (Accad. Lincei, Atti, 16. pp. 668–679, Nov. 17, 1907.)—The method of determinating the refractive index of an isotropic medium by measurement of the polarising angle is extended to the case of doubly-refracting media, it being shown that the position of the optic axis and the principal refractive indices can be found from determinations of the plane of polarisation of the incident and reflected beam, which determinations are made by means of the half-shadow polarimeter. The paper deals particularly with the case of uniaxal media; that of biaxal is to follow in a second paper, and the experimental data in a third.
S. G. S.

233. *Magnetic Double Refraction of Organic Liquids.* **A. Cotton, H. Mouton,** and **P. Weiss.** (Comptes Rendus, 145. pp. 870–872, Nov. 18, 1907.)—The authors find that the magnetic double refraction in nitrobenzine is proportional to the square of the field even when that field exceeds 31,000 units. In other liquids examples of double refraction of smaller values and both signs have been found. [See also Abstract No. 1508 (1907).]
E. H. B.

234. *Rotatory Magnetic Dispersion of Crystals near Absorption Bands.* **J. Becquerel.** (Comptes Rendus, 145. pp. 916–918, Nov. 25, 1907.)—Following up his previous researches the author now shows how from these experiments the dielectric constant may be calculated in another way, and this leads to a remarkable concordance. He also concludes that the rotatory dispersion in the vicinity of the bands is entirely due to the simultaneous effect of the abnormal dispersion and the separation of the bands into two components corresponding to the circular vibrations in opposite senses. [See also Abstracts Nos. 1140 (1899), 805 (1903), 1414 (1905), and 89 (1908).] E. H. B.

235. *Dispersion of Double Refraction and Crystal Structure.* **T. H. Havelock.** (Roy. Soc., Proc. Ser. A. 80. pp. 28–44, Dec. 9, 1907.)—Beginning

with a theory intended to apply to artificial double refraction produced in an isotropic medium, the author finds that the consequences could be expressed simply in the following manner: If n is a refractive index of the substance, the quantity $(n^2-1)^{-1}$ is altered by an amount independent of the wave-length, and varying only with the direction; this implies a small change in n which is proportional to $(n_0^2-1)/n_0$, where n_0 refers to a standard state of arrangement in regular cubical order.

Passing to natural crystals, anomalous dispersion of the double refraction is found occurring in regions away from absorption bands, and a theory modified to account for these cases leads to a consideration of the optical relations of crystal structure. In this connection a comparison is made between some recent work in two directions. On the one hand, we have attempts to explain crystal structure as a function of chemical constitution; the crystal being described as a homogeneous assemblage of spheres which are combined into sub-groups defining the crystal unit or molecule. On the other hand, we have work connecting the dispersion of double refraction in certain groups of minerals with their chemical constitution, some members being found to possess a minimum of double refraction. Consequently, it should be possible to explain the varieties of dispersion of double refraction by means of the structure of the crystal, and this is here attempted under the following assumptions: The crystal unit contains vibrating electrons, so that their combined effect is expressed by three principal equations connecting the polarisation of the unit with the effective electric field; if, then, these units are arranged in regular cubical order we have a medium with principal refractive indices along three fixed directions in space, and it is assumed that in this case we have regular decrease of the double refraction with increasing wave-length in regions away from absorption bands. But considering in general any other homogeneous assemblage, the author expresses the effect by a change in the effective electric field acting on the crystal unit; this effect is estimated by supposing, as a sufficient approximation, that the effective cavity is slightly ellipsoidal instead of spherical. Thus differences of packing of the crystal molecules are represented optically by variations in the ratios of the axes of the effective cavity, and in their directions in space compared with the polarisation axes of the individual unit. Combining these assumptions, it is here shown that they are sufficient for a descriptive theory covering the varieties of dispersion of double refraction found in natural crystals. E. H. B.

236. *Optical Constants of Glowing Metals.* **M. Laue** and **F. F. Martens.** (Phys. Zeitschr. 8. pp. 853–856; Discussion, p. 856, Nov. 15, 1907. Paper read before the 79. Naturforscherversamml., Dresden.)—If E_s and E_p are the emissive powers of a glowing metal surface for rays whose electric components are perpendicular and parallel respectively to the plane of incidence, then it is first shown that $E_s/E_p - \cos^2\phi = \sin^2\phi[2n\cos\phi - \cos 2\phi]/n^2(x^2+1)$, where ϕ is the angle of emission, n the refractive index, and x the absorption constant. All the quantities except the two last are measured by mounting a strip of glowing platinum on the table of a spectrometer, the telescope of which is replaced by a polarisation photometer. The results agree with those of Rubens and Hagen, but not so with Drude's for the values of n and nx.

R. S. W.

237. *Optical Properties of Solutions and Dissolved Substances.* **C. Chéneveau.** (Annal. Chim. Phys. 12. pp. 145–228, Oct., and pp. 289–398, Nov., 1907.)—A detailed account is given of a series of measurements of the refractive index, in the visible region only, of a series of aqueous salt solutions. A valuable feature of the earlier section of the paper is a chapter of 45 pages devoted to a description of recent refractometric methods ; these include (1) an interference method (Borgesius, Dijken) in which the adjustment is made by varying the thickness of columns of the liquid ; (2) an autocollimator method in which a 30° prism is immersed in the liquid and rotated until the incident light is reflected perpendicularly from the back surface of the prism and returns along its original path ; (3) the Pulfrich refractometer, with an ingenious addition for regulating and measuring the temperature of the liquid ; (4) a compensation refractometer (Féry) in which a liquid prism of fixed angle is balanced against a solid prism of variable angle. The last was largely used in the measurements, which are given, of the refractive indices of a series of some 50 salts, each salt being examined at a number of different concentrations. A very careful comparison was made of the Féry and Pulfrich refractometers, but it is remarkable that no attempt was made to work to a constant temperature, the temperatures for the different series varying from 18° to 22° C.

The later section of the paper contains a discussion of the relationship between refractive index, concentration, temperature, &c. Attention is called to the fact that the "optical constant" of the solute $K = \frac{n_s - n_w}{c}$ (where n_s = refraction - constant of the solution, n_w = constant for the solvent, c = concentration of the solution) shows a remarkable steadiness whether the constant n be that of Gladstone or that of Lorentz : in the case of sulphuric acid the total variation in the constant is only 3 per cent. when the concentration is changed from $c = 3$ to $c = 95$ per cent. H_2SO_4. The conclusion is arrived at that "the influence of the solute on the transmission of the luminous rays is an additive atomic property : *the optical constant of the solute is independent of the ionisation of the dissolved substance and is not influenced by the formation of hydrates.*" A chapter is devoted to a discussion of evidence that the molecular refractions are additive properties ; the conclusion is arrived at that the additive law is not strictly true, and that it is impossible to deduce refractive moduli for the separate radicals. For the section on dispersion reference must be made to the original memoir. The paper closes with a bibliography in which references are made to 146 papers on refraction.

T. M. L.

238. *Improvement of Celestial Photographic Images.* **P. Lowell.** (Lowell Observatory Bull. No. 31. Sept. 10, 1907. Nature, 77. p. 42, Nov. 14, 1907. Abstract.)—In the progress of planetary photography there has been a limit to the results set by the imperfect colour correction of the telescopic objective and the imperfect colour sensitiveness of the photographic plates employed. This has been partly remedied by the use of various coloured screens placed before the plate, but something more requires to be devised before the full power provided by the telescope is completely utilised. On examination of the colour curve of the objective it is found to be much flatter for the yellow than any other region, and also that the inclination of the curve towards the red is less than towards the blue. It would thus appear that a more efficient use would be made by excluding the blue light altogether, and to bathe the plate with such sensitisers as would make it record the yellow and red most effectively. The author hopes to arrange for this in readiness for the next favourable opposition of Mars.

C. P. B.

239. *Spectrophotometry of Normal and Colour-blind Eyes.* **F. L. Tufts.** (Phys. Rev. 25. pp. 433–452, Dec., 1907.)—The three definitions most frequently employed for "equal luminosity" are as follows: 1. Two similar surfaces, illuminated respectively by two lights of different colour, may be said to be of equal luminosity if, in the judgment of the observer, they appear equally luminous. 2. Two similar surfaces, white, with black markings on them, illuminated respectively by two lights of different colour, may be said to be of equal luminosity if, when placed at the same distance from the eye, the details can be distinguished with the same minuteness. 3. Two similar surfaces, illuminated respectively by two lights of different colour, are said to be of the same luminosity if, on rapidly replacing one by the other before the eye, there is no sensation of flickering.

A new form of spectrophotometer, due to the author, for the measurement of colour luminosities according to definition 3, is described in this paper, and the results of measurements of the luminosities of the different parts of the spectrum as they appear to normal and to colour-blind eyes are given. From his experimental results the author arrives at the following conclusions: 1. The retina of the human eye contains two distinct sense organs—one, the luminosity sense; the other, the colour sense. 2. The luminosity sense is affected qualitatively in the same way by light-stimuli of all wave-lengths within the visible spectrum so that it reacts, after fatigue, always in the same way, no matter what kind of light is used to fatigue the retina. 3. The relation between wave-length and luminosity (def. 3) in the case of a 50-c.p. incandescent lamp may, for most eyes, be represented by a given luminosity curve. 4. Deviations from this normal curve fall, for the most part, into one or the other of two classes. The point of maximum luminosity may be displaced (*a*) towards the red or (*b*) towards the violet as compared with the standard curve. 5. Persons possessing perfectly normal colour vision may have an abnormal wave-length luminosity curve, and colour-blind persons have luminosity curves of type (*a*) as often as of type (*b*). A. R.

240. *Constancy of Spectrum Wave-lengths.* **H. Kayser.** (Zeitschr. Wiss. Phot. 5. pp. 304–308, Aug., 1907. Astrophys. Journ. 26. pp. 191–194, Oct., 1907. Translation.)—Exner and Haschek have recently advocated the view that wave-lengths of spectral lines may be variable, according to the conditions of vapourisation of the substance [Abstract No. 2033 (1907)]. Kayser does not accept the evidence, and ascribes the effects to errors in the determinations of the standards used, and to unavoidable errors of observation; and as the standards used are in many cases originally due to Kayser, his opinion is very important on this point. This, of course, does not apply to the pseudovariability often noticed in lines known to be multiple in structure, the various components of which may be differently affected by outside influences. Kayser concludes that up to the present no evidence has been obtained for not regarding spectrum wave-lengths as perfectly constant.

C. P. B.

241. *Emission Spectra of Uranium Salts at Low Temperatures.* **M. Cantone.** (Accad. Sci. Fis. Mat. Napoli, Rendiconti, 13. 3. pp. 149–156, 1907.)—The author has investigated the groups of narrow bands exhibited by the spectra of uranium sulphate, uranium ammonium sulphate, ammonium uranate, uranium ammonium fluoride, uranium potassium acetate, uranyl nitrate, and uranium acetate at the temperature of liquid air. It is found that the lines for each of these compounds obey the law $1/\lambda = A + mB$, where λ is the wave-length of a line occupying the position m in the series ; the constant B has the same value, namely, about 84, for all the above compounds, but the characteristic coefficient is, in general, different for the different compounds. T. H. P.

242. *Standard Wave-lengths.* **P. Eversheim.** (Zeitschr. Wiss. Phot. 5. pp. 152–180, 1907. Astrophys. Journ. 26. pp. 172–190, Oct., 1907. Translation.)—At the Oxford Meeting of the International Solar Union it was decided that wave-length standards should be determined at intervals not exceeding 50 Å.U., and that the numerical values should have an accuracy of one-thousandth of an Ångstrom unit. The author describes the interferometer method proposed by Perot and Fabry, which he will employ in determining the wave-lengths, and gives examples of the calculations employed. C. P. B.

243. *Emission Spectra of Selenium.* **J. Messerschmitt.** (Zeitschr. Wiss. Phot. 5. pp. 249–278, 1907. Chem. Centralblatt, 2. pp. 879–880, 1907. Abstract.)—While the intensity of the lines in the vacuum-tube spectra of selenium varies with the gas pressure, the character of the lines is dependent upon the spark-length and the capacity of the tube. With high self-inductance the line spectrum changes into a band spectrum ; self-inductance also causing most of the spark lines to disappear, so that the resulting spectrum resembles the arc spectrum. The nature of the electrodes is also influential. Both the flame and vacuum-tube spectra show the same bands, but the spectrum becomes more continuous as the flame temperature increases.
L. H. W.

244. *The Relation between Absorption Spectra and Chemical Constitution.* Part VII. *Pyridine and some of its Derivatives.* **F. Baker** and **E. C. C. Baly.** (Chem. Soc., Journ. 91. pp. 1122–1132, July, 1907.) Part VIII. *The Phenylhydrazones and Osazones of α-diketones.* **E. C. C. Baly, W. B. Tuck, E. G. Marsden,** and **M. Gazdar.** (Ibid. pp. 1572–1584, Sept., 1907.)—VII. A spectroscopic study of the replacement of a CH group of the benzene ring by a nitrogen atom as in the pyridine compounds. Assuming that benzenoid tautomerism is due to pulsation of the ring, it may be said that the pulsation is more restrained in the pyridine than in the corresponding benzene compounds. VIII. The results of this study of absorption spectra are in continuation of those on the phenylhydrazones of simple aldehydes and ketones [Abstract No. 1563 (1906)]. D. H. J.

245. *Holmium.* **A. Langlet.** (Arkiv Kem. Min. Geol., Stockholm, 2. No. 32. pp. 1–14, 1907.)—The author has applied various fractionating methods to the further separation of fractions containing yttrium, erbium, and holmium, the spectra and the colours of the solutions being observed. The most satisfactory method is found to be fractional crystallisation of a mixture of the chlorides from hydrochloric acid which distils unchanged in composition. This method cannot, however, be used for the complete separation of these metals, as it is ineffective in presence of a large amount of yttrium. Fractions of unaltering atomic weights were separated, but the absorption spectra of their solutions were found to vary, so that constancy of the atomic weight is not a criterion of the elementary nature of the metal present. It is doubtful whether the band occurring in the red portion of these spectra belongs to holmium, since this band is almost equally intense in all the fractions, even when the other holmium bands are not observed. There is no evidence of a decomposition of holmium into several components. The molecular conductivity may possibly serve as a means of distinguishing fractions which exhibit no differences in their atomic weights or spectra. T. H. P.

246. *Influence of Red and Infra-red Rays upon Photoluminescence.* **E. L. Nichols** and **E. Merritt.** (Phys. Rev. 25. pp. 362–381, Nov., 1907.)—Investigations were made upon the luminescence of Sidot blende, and the chief divisions of the work are: (1) *The effect upon this luminescence of exposure to the longer waves before excitation.*—The effect of a given excitation in producing phosphorescence depends upon the previous history of the phosphorescent substance. The effect of exposure to red or infra-red rays is to restore a phosphorescent screen to a definite standard condition. Exposure to the longer waves *before excitation* exerts a very marked influence upon the rate at which the phosphorescence excited after this exposure will decay. Rest in the dark does not restore the substance to its standard condition in a satisfactory way. Even an exposure of 1 sec. to the rays from a 50-c.p. lamp with a ruby-red glass interposed is more effective in restoring the phosphorescent screen than 48 hours' rest. While the effect of rest is uncertain, waves in the red and infra-red region have a definite and positive effect in restoring the substance to its normal condition. (2) *The influence of the longer waves during excitation.*—A steady condition is reached under the influence of the exciting light, and this appears due to some new grouping of the molecules. The intensity of steady fluorescence will be made less by any agent which increases the rate at which the assumed favourable grouping is destroyed. It is precisely this effect which is exerted by the red and infra-red rays, but further experiments are required for a complete interpretation of the results. (3) *The effect of the longer waves during the period of the decay of luminescence.*—This was studied, and is shown by a series of curves which were obtained from experimental observations. A sudden drop in the intensity is shown at the instant that the long waves began to act. (4) *The influence upon the effect studied of the wave-length of the red and infra-red rays used.*—The results confirm those obtained by Dahms by a photographic method as to the action of waves of different wave-length in suppressing phosphorescence. Various maxima of phosphorescence were observed. The observations agree with the conclusion of Dahms that the action does not extend beyond 1·5 μ. Absorption of the active rays appears to be necessary before they can produce any effect upon phosphorescence. It seems probable that Sidot blende possesses broad absorption bands with maxima not far from 0·9 μ and 1·37 μ. It is intended to carry out further experiments. J. J. S.

REFERENCE.

247. *Optical Properties and Electron Theory.* **H. Erfle.** (Ann. d. Physik, 24. 4. pp. 672–708, Dec. 17, 1907. Extract from Inaug. Dissertation, München.)—The present work was undertaken as a continuation of P. Drude's researches in the same field [see Abstracts Nos. 3241 (1904), also 2044 (1905)]. Using Abbe's spectrometer the author determined for the three liquids, benzol, α-monobromnaphthalene, and methyliodide throughout the visible spectrum the constants in the dispersion formula: $n^2 = -k\lambda^2 + a^2 + D\lambda_v^2/(\lambda^2 - \lambda_v^2)$. E. H. B.

HEAT.

248. *Pyrometer Compensated for Room Temperature.* (West. Electn. 41. p. 424, Nov. 30, 1907.)—Describes with sketches the recently patented invention of C. B. Thwing. The pyrometer consists of a thermo-couple and galvanometer; and the novel feature of the galvanometer is the control spring or springs, which are made of compound strip, *e.g.*, iron and brass, whose differential expansion alters the initial position of the needle according to the atmospheric temperature. F. R.

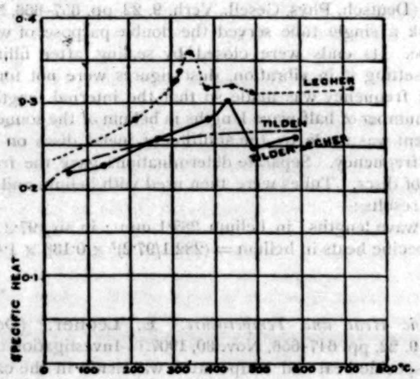
249. *Ratio of Specific Heats for Helium by Kundt's Tube.* **U. Behn** and **H. Geiger.** (Deutsch. Phys. Gesell., Verh. 9. 22. pp. 657–666, Nov. 30, 1907.) —In this work a single tube served the double purpose of wave tube and sounding tube. Its ends were closed by sealing, after filling with pure helium. On setting it in vibration, dust figures were not formed until an adjustment of frequency was made so that the internal length of the tube was an exact number of half-wave lengths in helium of the sound so produced. This adjustment was made by the addition of metal discs on the end, thus reducing the frequency. Separate determinations gave the frequencies for each number of discs. Tubes were then used with helium and with air with the following results:—

Mean half-wave lengths: in helium, 282·1 mm.; in air, 97·2 mm.

Ratio of specific heats in helium $= (282{\cdot}1/97{\cdot}2)^2 \times 0{\cdot}138 \times 1{\cdot}40 = 1{\cdot}63$.

E. H. B.

250. *Specific Heat and Temperature.* **E. Lecher.** (Deutsch. Phys. Gesell., Verh. 9. 22. pp. 647–656, Nov. 30, 1907.)—Investigation of the connection between specific heat and temperature was made in the case of Fe and Ni. Hitherto results obtained in such measurements have been vitiated: (1) Because the actual specific heat at a certain temperature was not determined, but always the mean specific heat between some higher temperature and that of the room; (2) because too little attention was paid to the avoidance of the effects of oxidation when the material examined was heated to a high temperature (600° to 1,000°). These sources of error are avoided in the method described by the author in which the wire examined is placed in a vacuum in a porcelain tube which can be heated in an electric oven. At a given part of the wire a small thermo-element is placed which is joined to a galvanometer. If now there is sent through the wire for a given time a measured alternating current, the galvanometer will show a deflection which is greater the greater the resistance of the wire and the smaller its specific heat. At four points along the principal wire at intervals of about 16 cm. small thermo-elements of constantan-iron are fixed, the main wire being doubled back parallel to itself twice, and the whole placed in a porcelain tube while this last is put in a large electric oven of Heræus' pattern. The wire examined had a thickness of 3 to 4 mm., while the diam. of the constantan-iron wires was 0·5 mm. Besides the porcelain tube there was placed in an oven a comparison thermo-element of constantan-iron, the temperature of the oven being measured by a standardised Pt-Rh and Pt thermo-element or by means of a standardised mercury thermometer. The thermo-elements referred to were each placed in a space exhausted of air. The series of e.m.f.'s along the main wire was now measured by the thermo-elements, and the e.m.f. of the comparison element determined also as nearly as possible at the same time. By simple reduction the actual temperatures along the wire were calculated, and the mean of these was taken as the mean temperature of the principal wire. Thus was found the dependence of the resistance on temperature, but the former was, of course, more accurately determined than the latter. The wires used on analysis were found to contain (1) nickel wire : Ni = 99·2 per cent., Fe = 0·47 per cent., C—calculated from difference, 0·33 per cent. ; (2) iron wire : Fe = 99·5 per cent. C and Mn (from difference) = 0·5 per cent. The results are expressed in the following curve with which that found by Tilden [Abstract No. 1889 (1908)] is put for comparison. The curve showing the relation between the specific heat and temperature in the case of nickel



shows a significant rise, about 320°. Tilden, expressing his results in the form $Q^2 + aQ + bt^2 + ct + f = 0$, obtains the actual specific heat at various temperatures from the expression dQ/dt. These are shown on the curve above. Lecher considers that various peculiarities in the results are thus lost, and has calculated the actual specific heat direct from Tilden's observations. Calling Q_t the specific heat on heating between t° and 0°, and Q_{t_1} that between t_1° and 0°, he takes as the actual specific heat at the temperature $(t + t_1)/2$ the magnitude $(Q_{t_1} - Q_t)/t_1 - t$. The curve so obtained is marked Tilden-Lecher. This curve shows also the sudden rise, though at a somewhat higher temperature. This variation may be due to the considerable extrapolation involved at temperature 400°, as Tilden's platinum-resistance thermometer was corrected by comparison in the vapour of boiling aniline (184° C.). Very similar results expressed in a corresponding curve were obtained in the case of iron, the sudden steepness of the curve taking place at a temperature a little over 700°. Here the results are compared with those previously obtained by Oberhoffer. While the author considers his results more accurate than any hitherto published, there are certain sources of error which he hopes later to eliminate, and he wishes his present research to be considered as preliminary. J. J. S.

251. *Physics of the Flame.* **H. Mache.** (Akad. Wiss. Wien, Sitz. Ber. 113. 2a. March, 1904; 116. 2a. July, 1907. Ann. d. Physik, 24. 8. pp. 527–552, Nov. 26, 1907.)—The surface of the inner blue cone of a Bunsen flame represents the junction between the mixed gases at their ignition-point and the burning gas. Since loss of heat has not had time to set in there, it is the hottest part of the flame [see Abstract No. 1080 (1906)]. The sine of the vertical angle of the cone measures the rapidity of propagation of the explosion, when the velocity of the jet is given. This rapidity is surprisingly small, not exceeding 50 cm. per sec. in the Bunsen flame, or 10 m. per sec. in the oxyhydrogen flame. The author seeks to bring this observation into harmony with the enormous speed of propagation observed in larger volumes and in explosive solids, which closely approaches the speed of propagation of sound. There is as a rule a very considerable difference of temperature between the unburnt gas and the burning gas, and a corresponding difference of density. Molecules flying from the cooler to the hotter regions are deflected towards the normal of the limiting surface, and *vice versâ.* When the molecule traverses the surface, it receives an impulse in the direction of the normal. A molecule from the burning gas, which transmits the explosion, loses energy, and becomes more tangential, though its path remains in the same plane, and maintains the tangential component intact. The energy transported acquires a maximum at a certain angle, which represents the direction in which the rate of propagation of the explosion is highest. The explosion is propagated, in fact, more easily laterally than normally. If the density of the unburnt body is very great, as in solid gunpowder, the explosion becomes practically tangential, and travels laterally over the surface of the grains. It then proceeds normally to the surface at the ordinary rate. When in a gas explosion the tangential speed approaches the velocity of sound it is further increased by the adiabatic compression and consequent heating of the unburnt gas. Its final maximum is the mean molecular speed of the products of combustion at the maximum temperature of combustion. Finally, the author shows that Gouy's theorem, according to which the material consumed is proportional to the flame surface, fails when the radius of curvature is of the same order of magnitude as the range of heat conduction, and also if the maximum explosive speed does not greatly exceed the normal speed. E. E. F.

252. *The Transition-temperature of Manganous Chloride as a Fixed Point.* **T. W. Richards** and **F. Wrede.** (Amer. Acad., Proc. 43. No. 10. pp. 343–350, Nov., 1907. Contribution from the Chem. Inst. of the Royal Friedrich-Wilhelm Univ., Berlin.)—As a fixed point which is sufficiently definite and constant, and, on account of the relative ease of the preparation of the salt in a pure form, convenient for use as a fixed point in thermometry, the authors have carefully determined the temperature of transition of manganous chloride from the tetrahydrate ($MnCl_2, 4H_2O$) to the dihydrate, and give it as $58^{\circ}{\cdot}089 \pm 0{\cdot}005$, on the international hydrogen scale. A tall transparent thermostat was used, by means of which it was possible to determine exactly the temperature of the whole length of the thermometer. F. R.

253. *Freezing-mixtures of Crystallised Sodium Sulphate and Hydrochloric Acid.* **L. Szydlowski.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 855–891, April, 1907. From the Phys. Inst. d. k.k. Univ., Graz.)—The properties of the freezing-mixture: crystallised sodium sulphate and concentrated hydrochloric acid, was investigated. The investigation involved: (1) Direct measurement of the lowering of temperature; (2) measurement of the cooling effects of the mixtures at 0° C. in a Bunsen's ice calorimeter; (3) measurement of the cooling effects and the specific heat of the mixtures above 0°; (4) quantitative analytical examination of the mixture after reaction. The results showed that: (1) The most concentrated acid is the best, since a smaller quantity is necessary in order to give the greatest cooling effect per 1 gm. of the mixture. The degree of concentration of the hydrochloric acid is only limited by the initial temperature of the materials employed. In the investigation 36·5 per cent. HCl and crystallised sodium sulphate in the form of fine meal were used. (2) Comparing the results of the measurements at different initial temperatures, it was found that the cooling effect was greater, the higher the initial temperature of the mixture. The most suitable initial temperature is defined by the stability of the materials used, and is about 20–25° C., since at higher temperatures the concentrated HCl fumes and the crystallised sodium sulphate loses some water. (3) The most suitable mixture of acid and salt was that which yielded no NaCl in the resulting mixture. This was found to be the case when—

$$\frac{\text{hydrochloric acid}}{\text{crystallised sodium sulphate}} = 0{\cdot}265$$

for 36·5 per cent. acid at initial temperature of + 15° C. (4) Under practically the same conditions the greatest temperature-lowering was 39·6° and the lowest temperature —18·6°. F. J. B.

254. *Condensation Nuclei.* **C. Barus.** (Phys. Rev. 25. pp. 391–398, Nov., 1907. Condensed from report to the Carnegie Inst. of Washington.)—The water nuclei obtained from the evaporation of fog particles precipitated on ions vanish in the successive exhaustion faster than in the corresponding case with the vapour nuclei of dust-free air; while the water nuclei from fog particles precipitated on vapour nuclei vanish much faster than is the case for the corresponding solutional nuclei obtained with phosphorus emanation. Charged nuclei are found to be destroyed in greater number than uncharged nuclei by the evaporation of fog particles precipitated on them. Experiments show an outstanding effect due to the number or the size of the nuclei. The coefficient of survival decreases as the number of nuclei increases, or better, as their size diminishes. It appears, moreover, that the peculiar loss of water nuclei resulting after evaporation of fog particles precipitated upon ions is due to this evaporation (or its equivalent), and not to the dissipation of the water nuclei in the lapse of time. J. J. S.

255. ***Heat of Volatilisation of Liquid Ammonia at its Normal Boiling-point.*** **E. C. Franklin and C. A. Kraus.** (Journ. Phys. Chem. 11. pp. 553–558, Oct., 1907.)—The latent heat of vapourisation of liquid ammonia was determined by making use of an electrical method of heating and measuring the total current required to vapourise a known volume of the liquid. The average value deduced was 341 cals., in fair agreement with the value, 337 cals., calculated by de Forcrand, but differing somewhat widely from Brill's value, 321 cals. Equally important is the agreement of the experimental value with that deduced by van't Hoff's equation from the absolute boiling-point, 239·5°, and the molecular elevation, for which the values 3·40, 3·37, and 3·46 were deduced by Franklin and Kraus; this gives the values 337, 341, and 332, mean 337, for the latent heat. T. M. L.

256. *Turbulent Motions of Gases.* **W. Wien.** (Phys. Zeitschr. 8. pp. 908–909; Discussion, pp. 909–910, Dec. 1, 1907. Paper read before the 79. Naturforscherversamml., Dresden.)—Through the investigations of Reynolds and Couette it has become known that regular streams become unstable when surpassing a certain speed. They then pass into a more stable condition of motion, which is accompanied by turbulence. The author examined the flow of gases through glass tubes from 0·1 to 2 mm. thick, using pressures as high as 200 atmos. Plotting curves of quantities and pressures, he found a sharp bend at a certain pressure, the curve being otherwise practically a straight line. On calculating the critical speed by Reynolds' formula, $u_0 = 1000/R(k^2/s)$, where R is the radius of the tube, k^2 the viscosity, and s the density, this is found to agree well with the velocity at the bend. But when the tube is short, the observed value of the speed is often too high, and this discrepancy is increased when the entrance end of the narrow tube does not project into the reservoir but tapers out into it. This is probably due to an abnormal maintenance of the unstable condition. The turbulence begins at the exit end of the tube, as may be shown by the steep gradient of temperature revealed by a thermo-couple mounted near the end. That the turbulence has a well-defined character suggests that it is governed by comparatively simple laws. These laws probably govern most of the phenomena of wind and waves.—In the *discussion*, **Prandtl** pointed out that theoretically turbulence should set in along the whole tube at the same moment, unless it required a certain length to develop itself in. **Bose** inquired whether any conclusions could be arrived at concerning the mechanism of the Gulf Stream. **Lecher** mentioned having sought a similar phenomenon in the case of a stream of electrons carrying a current of 11 amps. along a silver wire 0·08 mm. diam. cooled by water. In this wire the electrons should have a speed of some 75,000 cm. per sec. But no deviation from Ohm's law could be discovered which would indicate turbulence. The **Author** acknowledged the difficulty concerning the origin of the turbulence. He thought the Gulf Stream was a turbulent current, but could not say how far it was mixed with colder layers. E. E. F.

REFERENCES.

257. *Internal Temperature-gradient of Metals.* **S. B. Serviss.** (Amer. Journ. Sci. 24. pp. 451–486, Dec., 1907.)—Thwing's results [Abstract No. 1736 (1906)] for the gradient in ordinary substances being too large, according to Greinacher's computation, his experiments are repeated with metal cylinders, the method being substantially the same with the addition of some carefully carried-out improvements. The sensibility of the arrangements was such that a gradient of $1° \times 10^{-7}$ per cm. could have been detected. The results of the experiments were entirely negative. G. E. A.

258. *Coronas.* **C. Barus.** (Amer. Journ. Sci. 24. pp. 277–281, Sept., 1907. Extract from a forthcoming report of the Carnegie Inst., Washington.)—A description of a new modified method for the observation of coronas, in which two sources of light are employed. J. J. S.

259. *Ionised Nuclei.* **C. Barus.** (Amer. Journ. Sci. 24. pp. 419–425, Nov., 1907.)—A continuation of the papers by the author on this subject, dealing in the present case with the decay of ionised nuclei in the fog chamber in the lapse of time. J. J. S.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

260. *Electron Theory of Magnetism.* **Z. Thullie.** (Acad. Sci. Cracovie, Bull. 7. pp. 749–767, July, 1907.)—Introduces into the theories of Voigt and Thomson the assumption that the generation period of the magnetic field τ is not infinitesimal, but of the same order of magnitude as the period of revolution of an electron, and gives a more exact form of calculation. The author considers four stages in succession: (1) The original motion of the electron under the sole influence of the quasi-elastic forces; (2) the motion of the electron during the generation of the magnetic field, the electromagnetic wave being propagated in the direction of increasing X-co-ordinates; (3) the superposition of a wave propagated in the opposite direction, with similar magnetic force but reversed electric force; and thus finally (4) the motion of the electron in a constant magnetic field and $Y = 0$. The finite period τ requires a consideration not only of the speed, but also of the position of the electrons at the time when the wave arrives. The author's system of calculation further considers the local differences of electric force. These are not negligible, as assumed by Voigt, but of marked influence upon the final result. The main result is that the change in the total magnetic moment of the revolving electrons is solely due to the dependence of the electric component Y upon the position of the electrons in the magnetic field, or in other words, upon the time taken by the electromagnetic wave to arrive at their place. The change of Y with time at a given place is quite without influence, and n is the charge in the magnetic vector. The change of moment calculated by the author for electrons revolving in nearly circular orbits in all planes is identical with that calculated by Langevin [Abstract No. 842 (1906)]. The author concludes that the electron theory furnishes the simplest explanation of magnetic properties. Ampère's molecular currents are suitably represented by electrons in circular orbital motion about the centre of mass of the system. Diamagnetism is a general property of all matter. E. E. F.

DISCHARGE AND OSCILLATIONS.

261. *Increase of Voltage and Rectification of Currents obtained from Induction Coil.* **B. Jirotka.** (Elektrotechn. Zeitschr. 28. pp. 1187–1188, Dec. 12, 1907.)—Experiments carried out by the author have shown that by the introduction of a series spark-gap into the secondary of an induction coil, and the use of a spark-gap between one of the secondary terminals and earth, the voltage may be increased by about 100 per cent., and a rectification of the secondary currents may be effected when the primary is supplied with an alternating current, thereby enabling the arrangement to be used for Röntgen-ray work on alternating-current circuits. The increase of voltage is greatest when the spark-gap is adjusted so as to produce high-frequency oscillations. A. H.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

262. *Clark and Weston Standard Cells.* **F. A. Wolff** and **C. E. Waters.** (Bureau of Standards, Bull. 4. pp. 1–80, Dec., 1907. Electrician, 60. pp. 674–675, Feb. 14 *et seq.*, 1908. Abbreviated.)—The authors give a brief history of Clark and Weston cells and a description of the methods employed at the Bureau of Standards for setting up such cells. A section dealing with the comparing baths, thermo-regulator, &c., is inserted for the convenience of others who may wish to undertake standard cell work. The authors find that the agreement in e.m.f. of their Clark cells is on the whole somewhat better than that of the Weston standards, though on account of their tendency to crack and the fact that many of them are comparatively new, the observations are less complete than in the case of the Weston cells. In the opinion of the authors the use of the silver coulombmeter as one of the two fundamental electric standards is of doubtful utility, as it seems improbable that it has sufficient advantage from the point of view of reproducibility to compensate for greater inconvenience. Again, the standard cell is to be preferred since all voltage and current measurements of precision are made by the potentiometer method, and thus directly in terms of the standard cell or a combination of a standard cell and a standard resistance. In an appendix are given the results of a comparison of Weston cells exchanged with Foreign Laboratories. The e.m.f.'s of such cells set up at the Bureau of Standards, at the National Physical Laboratory, and at the Laboratoire Central d'Électricité, differ on an average by less than 1 part in 100,000. [See Abstract No. 122 (1908).] F. E. S.

263. *The Normal Weston Cadmium Cell.* **F. E. Smith.** (Roy. Soc., Phil. Trans. Ser. A. 207. pp. 393–420, Jan. 16, 1908. Roy. Soc., Proc. Ser. A. 80. pp. 75–76, Dec. 9, 1907. Abstract. From the National Physical Laboratory.)—The large temperature-coefficient of a Clark cell is a serious objection to its use in practical work. In addition Ayrton and Cooper have shown [Roy. Soc., Proc. 59. p. 368, 1896] that the lag of the e.m.f. of the cell behind the temperature when the temperature changes is very appreciable in the tube form of the cell. The author finds a similar lag in the Weston cadmium cell but the effect is extremely minute. He suggests that the temperature-coefficient for this cell, found from Jaeger and Kahle's formula, which he has verified, $E_t = 1{\cdot}0186 - 0{\cdot}000038\,(t-20) - 0{\cdot}00000065\,(t-20)^2$, be adopted. The e.m.f is probably constant over long periods of time, and the small charging and discharging currents to which it is subjected in potentiometer work do not seriously affect the value of the e.m.f. In an appendix the results of comparing the e.m.f.'s of Weston cadmium cells made at Washington, Paris, Berlin, and Teddington are published. The values of the e.m.f.'s of the various cells were found to differ only a few parts in 100,000. A. R.

264. *Variation of Light-sensitiveness of the Selenium Cell with Pressure.* **F. C. Brown** and **J. Stebbins.** (Phys. Rev. 25. pp. 501–502, Dec., 1907. Abstract of paper read before the Amer. Phys. Soc., Oct. 19, 1907.)—A continuation of previous work [Abstract No. 1042 (1905)]. The conclusions reached are: (1) The pressure effect is a genuine effect in the selenium itself and not a change in the contact resistance between the electrodes and the selenium, or between parts of the selenium itself. (2) The light-effect decreases with pressure. (3) The percentage decrease of resistance due to light is a function of the initial resistance whether the latter be conditioned by pressure or temperature. A table of results is given. G. E. A.

265. *Effect of Radium on the Resistance of the Selenium Cell.* **F. C. Brown** and **J. Stebbins.** (Phys. Rev. 25. pp. 505–506, Dec., 1907. Abstract of paper read before the Amer. Phys. Soc., Oct. 19, 1907.)—A Ruhmer cell was exposed to radium of from 2 to 3 million activity, and the decrease in the resistance of the cell with time of exposure measured with direct action of the radium, and with mica plates of different thickness interposed. The decrease of resistance varied from 30 to 0 per cent., the effect being due chiefly to the β-rays. The rate of recovery from exposure to radium is about five times less than for light exposures of short duration. G. E. A.

266. *Self-inductance of a Solenoid of any Number of Layers.* **L. Cohen.** (Electrical World, 50. p. 920, Nov. 9, 1907.)—The author gives the final results he has arrived at in a paper which will shortly be published in the *Bulletin* of the Bureau of Standards. The formula for the self-inductance L of a solenoid is—

$$\mathrm{L} = 4\pi^2 n^2 m \{(2a_0^4 + a_0^2 l^2)/(4a_0^2 + l^2)^{\frac{1}{2}} - 8a_0^3/3\pi\}$$
$$+ 8\pi^2 n^2 \big[\{(m-1)a_1^2 + (m-2)a_2^2 + \ldots\}\{(a_1^2 + l^2)^{\frac{1}{2}} - 7a_1/8\}$$
$$+ (1/2)\{m(m-1)a_1^2 + (m-1)(m-2)a_2^2 + \ldots\}\{a_1 h/(a_1^2 + l^2)^{\frac{1}{2}} - h\big]\}.$$

In this formula m is the number of layers, a_0 is the mean radius of the solenoid, $a_1, a_2, \ldots$ are the mean radii of the various layers, l is the length of the solenoid, h is the radial distance between two consecutive layers, and n is the number of turns *per unit length*. If, for instance, $a_1 = 5$, $h = 0{\cdot}1$, $m = 4$, $a_0 = 5{\cdot}15$, and $l = 50$, the centimetre being the unit of length. We get by the above formula—

$$\mathrm{L} = 4\pi^2 n^2 \times 18{\cdot}926 \text{ cm.}$$

Calculating L by Maxwell's formula we get—

$$\mathrm{L} = 4\pi^2 n^2 \times 21{\cdot}228 \text{ cm.}$$

The error of the latter, therefore, is 12 per cent. When $a_1 = 5$, $h = 0{\cdot}2$, $a_0 = 5{\cdot}4$, $m = 5$, and $l = 20$, we get $\mathrm{L} = 4\pi^2 n^2 + 10{\cdot}888$, and $\mathrm{L} = 4\pi^2 n^2 \times 14{\cdot}622$. In this case Maxwell's formula makes L 35 per cent. too great. Putting $m = 1$ in the above formula, we get for the self-inductance of a single-layer coil—

$$\mathrm{L} = 4\pi^2 a^2 n^2 \big[(2a^2 + l^2)/(4a^2 + l^2)^{\frac{1}{2}} - 8a/3\pi\big].$$

This should be compared with Russell's formula [see Abstract No. 1210 (1907)] for a coil, the length of which is greater than the diameter—

$$\mathrm{L} = 4\pi^2 a^2 n^2 l\,(1 - 8a/3\pi l + a^2/2l^2 - a^4/4l^4).$$

A. R.

267. *Recovery of Selenium Cells after Exposure to Light.* **E. Merritt.** (Phys. Rev. 25. pp. 502–505, Dec., 1907. Abstract of paper read before the Amer. Phys. Soc., Oct. 19, 1907.)—Observations on the recovery of selenium cells as influenced by the duration and intensity of the previous excitation. These bring out a remarkable resemblance between the behaviour of selenium as indicated by its change of conductivity, and the behaviour of a phosphorescent substance as indicated by the intensity of its phosphorescence. A cell with a resistance of about 50,000 ohms in the dark was illuminated by an acetylene flame for different periods. The difference between the observed conductivity C and the normal C_0 (in the dark) is taken, and $(C - C_0)^{-\frac{1}{2}}$ is plotted against the time *t*. The curves thus obtained are similar to those for the decay of phosphorescence in Sidot blende after exposure, obtained by plotting I and *t*, where I is the intensity of phosphorescence. It seems not unlikely that the rapid decay in the early stages, indicated by the curves, is due to the fact that the exciting rays penetrate only a short distance below the surface. After a short time the conditions are more nearly uniform and the decay more gradual. If the increased conductivity of selenium produced by light is due to temporary dissociation, as suggested by Bidwell, the linear relation between $(C - C_0)^{-\frac{1}{2}}$ and *t* corresponds to a substance of the type $CuCl_2$. G. E. A.

268. *Measurement of Self-inductance.* **G. Lignana.** (Accad. Sci. Torino, Atti, 42. 15. pp. 530–535, 1906–1907. Lumière Électrique, 1. pp. 180–181, Feb. 8, 1908.)—A new method is founded on the quadrature of two alternating currents in parallel circuits, one of which contains the inductance under examination and a variable resistance R, and the other a capacity C, and another variable resistance R′. The two currents are in quadrature when the relation $L = CRR'$ is satisfied, whatever may be the frequency employed. In order to test for quadrature, the author uses an electrodynamometer, having the fixed coil in series with the unknown inductance, and the movable coil in series with the condenser, and reduces the reading to zero by a suitable adjustment of the resistances. The method is independent of the form of the current, and is very sensitive. E. E. F.

269. *Self-inductance of a Toroidal Coil of Rectangular Section.* **E. B. Rosa.** (Bureau of Standards, Bull. 4. pp. 141–148, Dec., 1907.)—One of the most carefully constructed standards of self-inductance in the world was made by Fröhlich in 1897 [Abstract No. 804 (1898)]. It consists of a large marble ring of rectangular section wound with a single layer of fine silk-covered wire. Fröhlich calculated the self-inductance on the assumption that it was the same as for a current sheet the thickness of which was equal to the diam. of the bare wire. He found that $L = 0{\cdot}10199068$ henry. The author has previously pointed out [see Abstract No. 1907 (1906)] that the assumption that a winding of round wires is equivalent to a current sheet is inadmissible. He now gives simple examples to show that when the diam. of the wire is less than a certain value, *the finer it is the larger the error involved in this assumption.* He recalculates L, using Fröhlich's data, and finds $L = 0{\cdot}1021686$. He points out that with very fine wire the error due to the assumption that it is equivalent to a current sheet can easily be several per cent. In conclusion he states that the straight solenoid offers many advantages over the circular solenoid as a standard. It is easier to construct and measure the core and immensely easier to wind, and the calculation of L from the dimensions is quite as simple and the accuracy of the formula quite as high. A. R.

270. *Determination of Inductances of Solenoids.* **B. Strasser.** (Ann. d. Physik, 24. 5. p. 960, Dec. 31, 1907.)—The author gives a correction, suggested by Umow, to his formula previously given [Abstract No. 2090 (1905)]. The term in the square brackets there should read—

$$\left[\left(8 \log_e \frac{8r}{g} - 1\right) . \frac{n^2(n^2 - 1)}{12} - B\right].$$

L. H. W.

271. *On the Self-inductance of Circles.* **E. B. Rosa** and **L. Cohen.** (Bureau of Standards, Bull. 4. pp. 149–159, Dec., 1907.)—The formula for the self-inductance L of a circular current was first given by Kirchhoff in the following form :—

$$L = 2l[\log_e(l/\rho) - 1{\cdot}508],$$

where l is the circumference of the circular axis and ρ is the radius of the cross-section. If a be the radius, so that $l = 2\pi a$, we get—

$$L = 4\pi a[\log_e(8a/\rho) - 1{\cdot}75].$$

More accurate formulæ were then obtained by Maxwell, Rayleigh, and Wien. To illustrate the accuracy of the various formulæ the following cases are considered :—

Dimensions of Rings.	$a = 25, \rho = 0{\cdot}05$ $\rho/a = 1/500.$	$a = 25, \rho = 0{\cdot}5$ $\rho/a = 1/50.$	$a = 10, \rho = 1{\cdot}0$ $\rho/a = 1/10.$
L/π by Wien's formula	654·40587	424·1761	105·497
L/π by Maxwell's formula	654·40538	424·1734	105·476
L/π by Rayleigh's formula......	654·40548	424·1781	105·517
L/π by Kirchhoff's formula ...	654·40496	424·1464	105·281

The results are arranged in the probable order of accuracy, the last being admittedly the least accurate. Even for the smallest ring of radius 10 cm. and diam. of section 2 cm. Maxwell's formula gives a result 1 part in 5,000 too small, Rayleigh's a value as much too large, and the simple approximate formula of Kirchhoff is in error by only 0·5 per cent. Russell's simple method of proving Kirchhoff's formula is quoted [see Abstract No. 1210 (1907)]. Minchin's formula (Phil. Mag. 37. p. 300, 1894) is wrong, as he neglects entirely all the lines of force wholly within the ring. His formula for the self-inductance of a superficial current is also wrong. W. M. Hicks (Phil. Mag. 38. p. 456, 1894) has misinterpreted Maxwell's approximate expression for the self-inductance of a ring. By the use of toroidal functions Hicks obtains two formulæ for the self-inductance : (1) L_u when the current density is uniform, and (2) L_v when the current density is inversely as the radial distance from the axis. Evaluating these formulæ for the three rings considered above, the authors get—

	$\rho/a = 1/500.$	$\rho/a = 1/50.$	$\rho/a = 1/10.$
L_u/π	654·3898	423·802	102·7900
L_v/π..................................	654·4048	424·130	105·2888

Wien has also worked out a formula for L_v. By this formula we get—

L_v/π.............................. 654·40617 424·2326 105·902

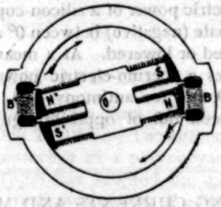
It will be seen that Hicks's results are less accurate than those given by Kirchhoff's approximate formula. They were derived by a very elaborate process which involved successive approximations. It is evident that the errors occurring in these approximations exceeded the total value of the small correction terms which it was the object of the investigation to determine.

A. R.

272. *Mutual Inductance of Coaxial Coils.* **H. Nagaoka.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. 9. pp. 192–195, Oct., 1907.)—Many formulæ have recently been proposed for calculating the mutual inductance of coaxial coils. The author divides them into two classes: (1) The elliptic integral formulæ, and (2) the series formulæ. To the former class, for instance, belong formulæ given by Himstedt, Jones, Russell, and Cohen and to the latter, formulæ given by Maxwell, Heaviside, Gray, Searle, Russell, and Rosa. In practice, the first class of formulæ are sometimes very laborious to evaluate. The author, however, by utilising the known transformations of q series in elliptic functions shows how the arithmetical labour involved in the evaluation can be very considerably abbreviated. His formulæ also obviate the necessity of using Legendre's tables. A. R.

273. *New Alternator for High-frequency Currents and Wireless Telegraphy.* **P. Villard.** (Archives d'Él. Médicale, 15. pp. 922–928, Dec. 10, 1907.)—The principle on which this alternator is based and oscillograms therefrom have previously been given [Abstract No. 1347B (1907)]. The author now gives a diagrammatic cross-section of the machine which is reproduced in the Fig. One advantage offered by such an alternator when used for radiographic work or for generation of high-frequency currents consists in the fact that, owing to the wave-form, when the alternator is delivering 100 volts effective and is connected to a transformer of ratio 250, the effective voltage of 25,000 obtained corresponds to a maximum value of 75,000 or 80,000 volts, or a spark length of 9–10 cm. The use of very high transformation ratios is thus rendered unnecessary; the only additional appliance required is a single valve tube, all the complicated capacity arrangements being dispensed with. The number of discharges can be varied from 25 to 40 per sec. by altering the speed from 750 to 1,200 r.p.m., or twice this number if 4 inductors are employed. The disadvantages are: the noise, necessitating a separate building, the size, and the cost. But where a complete and self-contained installation is desired the advantages preponderate. For wireless telegraphy purposes, at 900 r.p.m., 30 double reversals per sec. are obtained—the currents during which have a proper frequency of 150—and 30 sparks only; while an ordinary alternator of 150 ∾ would give 300 sparks. For inductive excitation, using less than 2 h.p., a primary voltage of 50 and a transformation ratio of 100, the alternator easily charges capacities of 1/20 mfd. to a potential sufficient for good 5–6-mm. sparks; and, whatever the speed of rotation of the machine, these sparks are truly oscillatory, and, contrary to the usual tendency, there is no liability to arcing and hence no arc-extinguishing device is needed.

L. H. W.



274. *Sulphur as an Insulator.* **F. J. Jervis-Smith.** (Nature, 77. p. 149, Dec. 19, 1907.)—An account of the behaviour of an electroscope insulated by means of sulphur. The author considers that the insulating property of sulphur is not sufficiently utilised in laboratories. A dry pile which has been used in the Clarendon laboratory for the last 42 years for striking a small bell was constructed with sulphur as the insulator. G. E. A.

275. *Thermo-electric Behaviour of Metallic Silicon.* **Miss F. G. Wick.** (Phys. Rev. 25. pp. 382–390, Nov., 1907.)—Silicon is an element of peculiar interest, standing as it does in the periodic system between the metals and non-metals. The thermo-electric properties were examined with some difficulty owing to the great brittleness of silicon. Soldering was impossible, and copper-plating in order to form a junction was used, but not with entire success. The temperature of the ends of a silicon rod was measured by means of a copper-constantan couple, and determinations of the thermo-e.m.f. at temperatures between 350° and —190° C. were made. The direction of the current was found to be from Si to Cu through the hot junction. Thus silicon is thermo-electrically negative with respect to Cu. Since Pb is also negative with respect to Cu, the e.m.f. which would be generated between Pb and Si must be the difference between that generated by Cu-Si and Cu-Pb junctions at the given temperature. Curves giving the computed values are given in the paper, as well as tables and curves showing the results of the observations made. It appears that the thermo-e.m.f. generated by a lead-silicon junction is very large. Also, the curve is not parabolic, but at least of the third degree. This is possibly due to a large Thomson-effect. The line indicating the thermo-electric power of a silicon-copper couple is not straight, but has a maximum ordinate (negative) between 0° and 100° which diminishes as the temperature is raised or lowered. At a mean temperature of 20° C. a lead-silicon junction gives a thermo-electric power of about —400. The value for bismuth is —89, and for antimony +26. Tellurium and selenium are comparable with silicon but of opposite sign, being +502 and +807 respectively. J. J. S.

ALTERNATING CURRENTS AND MAGNETISM.

276. *Resistance of Solenoid for Alternating Current.* **A. Sommerfeld.** (Ann. d. Physik, 24. 4. pp. 609–634, Dec. 17, 1907.)—The paper is entirely mathematical, the solenoid being treated as infinitely long and of infinite diam., so that the magnetic field is uniform and the conductor a series of parallel linear wires in one plane, the magnetic field being confined to one side of the plane. The distribution of current in the conductor and the magnetic field are found for low and for high frequencies. It is found that the ratio of the resistance for high-frequency current to that for continuous current is proportional to the square root of the frequency—a result which is in agreement with that previously given. [See Abstract No. 133 (1908).]
S. G. S.

277. *Magnetic Results of Ziegler Polar Expedition.* **J. A. Fleming.** (Terrestrial Magnetism, 12. pp. 105–124, Sept., 1907. Abstract.) The scientific work of this expedition during the years 1903–5 embraced investigations in the sections: (1) Magnetic Observations, (2) Aurora Borealis, (3) Meteorology, (4) Tidal Observations, (5) Astronomical Determinations, (6) Map Construction and Survey Work, all being carried out by a staff of five persons. Magnetic observations were made with a sine magnetometer and a

dip circle at four stations—Camp Abruzzi, Teplitz Bay, Rudolf Island, and Franz Joseph Archipelago. From the long series of observations at Teplitz Bay it appears that the principal maximum and minimum of east declination occur at earlier and later times respectively than for stations in lower latitudes. The increase in diurnal range from winter to summer is also quite pronounced. In general the curves also show a secondary maximum and minimum between the two principal extremes of each day; in several cases the minimum of this secondary wave exceeds the principal western deviation in amount. The secondary wave is very prominent in winter. It was noted that magnetic storms were very frequently associated with displays of *aurora borealis*. The converse was not found, however, *i.e.*, auroral phenomena were not always accompanied by magnetic disturbances.
C. P. B.

278. *Solar Activity and Magnetic Perturbations.* **Cirera** and **Balcelli.** (Comptes Rendus, 145. pp. 862–864, Nov. 18, 1907.)—The solar activity is estimated from the photographic records of spots, flocculi, and prominences taken with the spectroheliograph, and it is found that the magnetic perturbations coincide (1) with the passage of a region of solar activity over the central meridian; (2) with the appearance of an active region at the sun's east limb; (3) with an unusual variation of solar activity. Evidence is obtained that the aspect of the solar disc, with reference to the presentation of its axis to the earth, has considerable influence on the degree of perturbation produced.
C. P. B.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

279. *New Quantimeter for Röntgen Rays.* **H. Guilleminot.** (Comptes Rendus, 145. pp. 711–713, Oct. 28, 1907.)—The author employs in his method the comparison of the luminescence of a platinocyanide surface exposed to radium. As unit of intensity he has adopted the quadruple of the luminescence produced by 0·02 gm. radium bromide, of activity 500,000, spread on a circular surface of 1 cm. diam. and placed 2 cm. from the fluorescent surface. This intensity acting for 1 min. is the author's unit of quantity, which he designates by M. Other things being equal, 1M = 1/125H (about), where H is the unit of Holtzknecht. The author considers this unit small enough to be a useful magnitude in radiography and radiotherapy. Thus 1M of No. 5 rays will suffice for the radiographing of a hand, 4M for a shoulder, &c. The quantimeter which effects the summation of the number of M units during the exposure, is described; but as this "automatic totaliser" is somewhat complicated and no explanatory diagram given the original pages should be referred to for details.
L. H. W.

280. *Comparison of the Effects of Radium and of Röntgen Rays upon Vegetable Cells.* **H. Guilleminot.** (Comptes Rendus, 145. pp. 798–800, Nov. 11, 1907. Archives d'Él. Médicale, 15. pp. 941–942, Dec. 10, 1907.)—The author has investigated the action upon a series of seeds, of a varying number of M-units [see preceding Abstract] of soft Röntgen rays, hard Röntgen rays, and radium rays. As a result he concludes (1) that the characteristic effect produced is a *retardation* of growth when the dose is sufficiently strong; (2) that the dose which distinctly has a retarding effect appears to be 3,000M for radium and 15,000M for Röntgen rays; (3) that the fatal dose is about 10,000M for radium, while with 20,000M of Röntgen rays the greater number of the plants will reach the first stages of growth and a few even arrive, with difficulty, at the adult stage; (4) that the accelerating action, if it exists, appears to occur at about 250–500M with radium and at 5,000–7,500M with Röntgen rays. The action on the whole is, however, not sufficient to definitely affirm that such an acceleration is produced. L. H. W.

281. *Possibility of establishing the Diagnosis of Death by Radiography.* **C. Vaillant, E. de Bourgade de la Dardye.** (Comptes Rendus, 145. pp. 885–887, Nov. 18, and pp. 942–943, Nov. 25, 1907.)—If a radiograph be taken of the abdomen of a cadaver a clear diagram is obtained of the stomach and intestines in which the convolutions are depicted with all their details. In the living subject these organs are not seen at all. The author suggests that the formation of H_2S in the intestines is the cause of this phenomenon. H. W. P. Y.

282. *Determination of the Quantity of Röntgen Rays absorbed by different Tissues.* **H. Bordier.** (Archives d'Él. Médicale, 15. pp. 929–935, Dec. 10, 1907.)—Three blocks of animal tissue each 1 cm. thick, placed one above the other, were exposed to the action of a Röntgen-ray tube, indicating pastilles being placed beneath each block. The following figures were obtained for muscular tissue: 1 cm. absorbed 63 per cent., transmitted 37 per cent.; 2 cm. absorbed 77 per cent., transmitted 23 per cent.; 3 cm. absorbed 88 per cent., transmitted 12 per cent. Mammary gland tissue is less absorbent, 1 cm. retaining 53 per cent. as compared with 63 per cent. for muscle, while for adipose tissue the figure is 43·4 per cent. H. W. P. Y.

REFERENCES.

283. *Radiation from Electron Groups.* **G. A. Schott.** (Ann. d. Physik, 24. 4. pp. 635–660, Dec. 17, 1907. Physikal. Inst. d. Univ., Bonn, Nov. 4, 1907.)—This highly analytical paper commences with a transformation of Lorentz's potential; it then passes to a simple periodic motion of one electron, electron groups and their electric and magnetic forces, radiation, a system of *n*-electrons describing a circle with uniform speed, disturbances of these electrons in the ring and their potential, and radiation of the disturbance, concluding with spectral lines and series. E. H. B.

284. *Relativity Theory of Electrodynamics.* **A. Sommerfeld.** (Phys. Zeitschr. 8. p. 841; Discussion, pp. 841–842, Nov. 15, 1907. Paper read before the 79. Naturforscherversamml., Dresden.)—Discusses a supposed objection to the theory which is here stated to be invalid. [See Abstract No. 1295 (1907).] E. H. B.

285. *Radiation Resonance.* **V. W. Ekman.** (Ann. d. Physik, 24. 2. pp. 267–289, Nov. 12, 1907.)—A mathematical treatment of electric oscillators used also as resonators. The special cases considered are (1) two like linear oscillators, (2) two unlike oscillators, and (3) two linear oscillators in relative motion. E. H. B.

286. *Spark-resistance.* **H. Barkhausen.** (Phys. Zeitschr. 8. pp. 624–632, Oct. 1, 1907.)—A theoretical consideration in which the spark discharge is treated as a special case of the alternate-current arc. L. H. W.

287. *Lightning Stroke.* **M. Luizet.** (Comptes Rendus, 145. p. 780, Nov. 4, 1907.)—During a violent thunderstorm the author observed, on Aug. 15, near Grenoble, an almost vertical, little ramified flash, succeeded one second later by another flash, following apparently exactly the same path, but cut up into luminous spots (*en chapelet*). The distance from the observer was estimated, by the time-interval of the thunder, at 7 km. H. B.

288. *Thermo-electric Properties of Nickel.* **H. Pécheux.** (Comptes Rendus, 145. pp. 591–593, Oct. 7, 1907. Écl. Electr. 53. pp. 160–161, Nov. 2, 1907).—An account of the thermo-electric behaviour of three different specimens of Ni and the influence on this of the presence of small quantities of other metals in differing proportions. J. J. S.

289. *New Flame-collector.* **C. W. Lutz.** (K. Bayer. Akad., München, Ber. 36. p. 507, 1906. Zeitschr. Instrumentenk. 27. pp. 289–291, Sept., 1907.)—Radium-collectors are not suitable for use when not only the potential gradient but also the conductivity and ionic density of the air are to be determined. Flame-collectors can then be employed, and the author describes one he has constructed free from the usual defect of the portable instruments whose flame is extinguished by a comparatively slight wind. J. J. S.

290. *Induction-spark.* **O. M. Corbino.** (Accad. Lincei, Atti, 16. pp. 51–58, July 7, 1907.)—The quantity of electricity passing in an induction spark is in agreement with the hypothesis that the quantity $Q = a. + b/i$ (as in the arc) with constants derived from continuous currents. A. D.

291. *The Secondary Current of the Induction Coil.* **H. C. Snook.** (Frank. Inst., Journ. 164. pp. 273–283, Oct., 1907.)—The secondary current of a 20-in. Ruhmkorff coil is investigated by means of a Duddell high-frequency oscillograph, electrolytic, mercury jet, and mechanical vibrator interrupters being used. A number of oscillograph curves are obtained under varied conditions of sparking, &c., and the curves are illustrated and discussed in turn. G. E. A.

292. *The Sparking Coil Condenser.* (Elect. Rev. 61. pp. 668–669, Oct. 18, 1907.)—A somewhat condensed account of an experimental investigation in which the effect of varying the position of the condenser in the primary circuit is examined as well as that of including additional resistance. L. H. W.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

293. *Atomic Weight of Nitrogen.* **D. Berthelot.** (Comptes Rendus, 145. pp. 65–67, July 1, 1907.)—The author shows that the determination of the molecular weights of gases by indirect methods of calculation, for example, from the densities either at corresponding temperatures and pressures or at high temperatures, leads to inaccurate results. The only direct and exact method is that in which the limiting densities are employed, and this method gives for the atomic weight of nitrogen the values 13·999 (from N_2O), 14·006 (from NO), and 14·008 (from N_2), the mean being 14·004. T. H. P.

294. *Capacity of the Elements of Forming Compounds with each other.* II. **G. Tammann.** (Zeitschr. Anorg. Chem. 55. 3. pp. 289–296, Sept 11, 1907. Inst. f. anorg. Chemie d. Univ., Göttingen.)—The data available to date strengthen the conclusions reached in a previous paper [Abstract No. 1627 (1906)]. All the known binary compounds of metals with one another are tabulated. When in a "natural group" there is a gradation from metalloidal to metallic properties from end to end of the group [as As, Sb, Bi or Ge, Sn, Pb], there is a difference between the tendencies which the members of the group have to form compounds with another given element. The members of a natural group of metals whose spectra exhibit series of lines (*e.g.*, Zn, Cd, Hg), combine similarly with a given element, but there are differences between the abilities to form compounds, in the case of the members of a group which do not give series of lines. F. R.

295. *Relations between Atomic Weights.* **Delauney.** (Comptes Rendus, 145. pp. 1279–1280, Dec. 16, 1907.)—Upon writing the atomic weights of elements in the form A^2/n in which A and n are whole numbers, certain resemblances and possible relations appear between the atomic weights of related substances; *e.g.*, we have Li, $13^2/24$; Rb, $47^2/26$; Cs, $61^2/28$. Some of these resemblances are made more apparent by using the form A^2a^2/na^2; thus—

C	Zr	Si	Ti	Ce	F	Br	Cl	I
$12^2/12$	$33^2/12$	$16^2/9$	$17^2/6$	$29^2/6$	$19^2/19$	$39^2/19$	$45^2/57$	$85^2/57$

F. R.

296. *Thermodynamic Recurring Formula for Atomic Weights.* **A. L. Bernoulli.** (Zeitschr. Elektrochem. 13. pp. 551–555, Aug. 16, 1907. Paper read before the 14. Hauptversamml. d. Deutsch. Bunsen-Gesell., Hamburg, May 12, 1907.)—The apparent atomic weight of an element may be regarded as a kinetic mean value and the element itself as a mixture of polymerides of hydrogen, in just the same way as we speak of the molecular weight of sulphur vapour, although the latter is looked upon as a mixture of the molecules S, S_2, S_4, &c. With the aid of certain assumptions, the author calculates thermodynamically all the possible atomic weights which such mixtures of polymerides are capable of assuming. These atomic weights, which need not be integral multiples of that of hydrogen, differ but slightly

from the real atomic weights and the small differences have been diminished from year to year by the alterations made by the International Committee for Atomic Weights. For example, the author's value for silver, 107·617, is practically identical with the number 107·615, given by the latest researches of Richards. Further, this atomic weight of silver leads to the value, 13·931, for nitrogen, while the author's formula gives 13·928. T. H. P.

297. *Method for determining simultaneously the exact Atomic Weights of all the Elements present in a Single Chemical Reaction.* **G. D. Hinrichs.** (Comptes Rendus, 145. pp. 715–718, Oct. 28, 1907. Extract.)—If $x, y, z \ldots$ are the errors in the experimental values; X, Y, Z ... the absolute atomic weights (in round numbers), giving $X + x$, $Y + y$, $Z + z \ldots$ for the exact atomic weights, and ΔX, ΔY, $\Delta Z \ldots$ the variations produced in the atomic ratio R by an increase of 0·1 in the atomic weight specially considered, then the equation of condition is represented by $x\Delta X + y\Delta Y + z\Delta Z + \ldots = 10e$, where e represents the analytical excess. For two variables (or elements) this equation represents a line and for three, a plane. When a given chemical investigation is represented graphically in this way, the perpendicular drawn to it from the origin gives the minimum deviation of experiment from the absolute value, and the projections of this perpendicular on the axes X, Y, Z are the linear errors from which the values of x, y, z are obtained. Using this method, the author finds the values 35·5 − 0·000807 and 108 + 0·00082 for the exact atomic weights of chlorine and silver. From the work of Urbain on terbium, the values H = 1 − 0·0000007, O = 16 − 0·0000007 and Tb = 159 + 0·00000542 are calculated, and from that of Curie on radium the value Rd = 226·5. T. H. P.

298. *Size of Colloidal Particles.* **A. Mayer, G. Schaeffer,** and **E. Terroine.** (Comptes Rendus, 145. pp. 918–920, Nov. 25, 1907.)—The addition of traces of alkali to an ultramicroscopic suspension has the effect of increasing the size of the colloidal grains if the solution is positive, and of diminishing it if the solution is negative. The addition of acid produces the reverse effect. The author instances colloidal metals, inorganic compounds like arsenic trisulphide, soaps, dyes, alkaloids, starch, and albumen. If the electric sign of the body is known, its colloidal state may be influenced in this manner by adding acids or alkalies. E. E. F.

299. *Valency of dissolved Molecule deduced from its Dispersion.* **C. Chéneveau.** (Comptes Rendus, 145. pp. 176–178, July 16, 1907.)—Calculates the inferior limit pv of the number of electrons capable of influencing dispersion in the dissolved molecule. This depends upon the molecular weight, the specific charge of the electron, and the optical constants of two different wave-lengths. The limiting value of the quantity pv is always of the order of magnitude of the total valency of the molecule. This total valency must not be considered as the sum of the valencies of the atoms, but as the sum of the valencies of the metallic atom and of the acid radical. E. E. F.

300. *Action of Light on the Formation of Sulphuric Acid.* **A. Coehn.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 3. pp. 271–279, 1907. Zeitschr. Elektrochem. 13. pp. 545–548; Discussion, pp. 549–550, Aug. 16, 1907. Paper read before the 14 Hauptversamml. d. Deutsch. Bunsen-Gesell., Hamburg, May 12, 1907.)—The author studies the influence of light from a mercury lamp of (1) quartz and (2) Uviol glass on the reaction $2SO_2 + O_2 = 2SO_3$. With the Uviol glass lamp the decomposition of the sulphur trioxide is considerably less than with quartz. Light exerts two distinct functions on the equilibrium of a mixture of sulphur dioxide and trioxide and oxygen; firstly, it acts as a catalyst in the formation of sulphur trioxide, and secondly, in decomposing the sulphur trioxide of a system stable in the dark it gives up a considerable amount of energy. Consequently the light intensity must influence the equilibrium, and it is found that the equilibrium constant $k = [SO_2]^2 . [O_2]/[SO_3]^2$ has the value $8{\cdot}2 \times 10^{-6}$ with a current of 9 amps., and $1{\cdot}4 \times 10^{-6}$ with 6 amps., the corresponding yields of sulphur trioxide being 65 and 78 per cent. respectively. T. H. P.

301. *Three New Electrical Resistance Furnaces.* **K. Friedrich.** (Metallurgie, 4. pp. 778–781, Nov. 22, 1907. Communication from the Metallograph. u. Metallurg. Laborat. d. Kgl. Bergakademie, Freiburg.)—I. The ordinary porcelain tube furnace, with a vertical branch upwards from the centre of the horizontal tube. Both portions of the tube are wound with platinum tape. This form is specially adapted for purposes in which uniformity of heating is desirable, and at the same time availability of the upper surface of the sample, for pyrometry, is required. II. A space in a block of refractory material is shaped in plan somewhat like a horseshoe, and is filled with kryptol. Carbon electrodes lead the current through this resistor, whose depth is the same as that of the cylindrical hole in which the crucible is placed. The cover has a corresponding resistor. This type is most useful for maintaining medium temperatures (800° to 1,000°) for a long time. III. The two electrodes are vertical; the granular resistor occupies a deep vertical slot in a block of refractory material, and divides at its centre to surround the crucible, which is a tall cylinder of small diam. Using a block of lime lined with a special mixture (not specified), the furnace has been in good condition after heating 100 times. Nickel is melted in this furnace in a few min., without the outside becoming perceptibly warm. This type is particularly adapted for metallographic work. F. R.

302. *Spongy Acid Vanadates of Univalent Metals.* **W. Prandtl** and **H. Murschhauser.** (Zeitschr. Anorg. Chem. 56. 2. pp. 178–208, Nov. 25, 1907. Lab. f. angew. Chemie an d. Kgl. Univ., München, Sept., 1907.)—This is a study of the conditions of formation of the spongy form (*Spratzen*) by evolution of gas during solidification, in the case of some series of vanadates of the univalent metals. The gas evolved is oxygen, and its amount when different proportions of V_2O_5 and the oxide (or carbonate, phosphate, nitrate, &c.) of the univalent metal, M'_2O (M' being Li, Na, K, Rb, Cs, or Ag), are melted together was observed, and curves are given. The observed evolution of oxygen followed in a roughly approximate manner what is required by the equations expressing the reactions, but was generally somewhat less in amount. The presence of B_2O_3 had very little effect upon the reaction; but with P_2O_5 a vanadylphosphate was formed, and the solidification occurred without any evolution of gas, and the solidified melt was glassy, but not at all spongy. Photographs of spongy vanadates are given. F. R.

303. *The Ternary System: Lead-Cadmium-Mercury.* **E. Jänecke.** (Zeitschr. Phys. Chem. 60. pp. 399–412, Sept. 24, 1907. Communication from the Kgl. Techn. Hochschule, Hannover.)—The author gives the complete solidification surface for the system, but the data for the changes in the solid state are not quite complete. The surface consists of six fields, as follows :—

Phase separating.	Field.
Cd	Cd A *a*
Pb	Pb *a* A B C
Pb Hg α	Pb C D *k*
Hg Pb β	Hg *k* D
Cd Hg α	Cd A B *b*
Cd Hg β	*b* B C D Hg

The phases with suffixes α and β are solid solutions. The co-ordinates of the various points are given in the following table :—

Point.	Atoms per cent.			Temperature.
	Pb	Cd	Hg	
a	67	33	—	249°
b	—	65	35	188°
k	near 0	—	near 100	—40° (approx.)
A	14·5	78·5	12	285°
B	7	57	36	169°
C	8·5	17·5	74	50° (approx.)
D	near 0	near 0	near 100	—40° (approx.)

F. R.

304. *Zinc-Nickel Alloy.* **V. Tafel.** (Metallurgie, 4. pp. 781–785, Nov. 22, 1907. Communication from the Metallograph. u. Metallurg. Laborat. d. Kgl. Bergakademie, Freiburg.)—Gives the temperature-concentration diagram for Zn-Ni alloys containing from 0 to 50 per cent. Zn. The melting-point of Zn is taken as 419°. There is a eutectic at 418·5, whose composition is almost pure Zn. It occurs in alloys containing up to 12·2 per cent. Ni. From 12·2 to 23·0 per cent. Ni a constituent (apparently a solid solution) occurs, and at 23·0 per cent. Ni the alloy is entirely the compound $NiZn_3$. Alloys containing from 23 to 45·8 per cent. Ni undergo a change at about 640°. There is a eutectic at 870° from 23 to 39·7 per cent. Ni. Above 45·8 per cent. Ni the alloys have a change-point at 780°, and there is a eutectic at about 1,085°. As the melting-point practically coincides with the boiling-point at about 60 per cent. Ni, it was not practicable to push the study further in this direction. All the alloys were very brittle, especially the compound $NiZn_3$. F. R.

305. *Temperatures in Nickel Metallurgical Processes.* **W. Woltmann** and **W. Mostowitsch.** (Metallurgie, 4. pp. 799–800, Dec. 8, 1907.)—Observations were made with the Wanner pyrometer at the Nickelhütte Frankenstein, Schleswig. The temperature at the receiver level in a water-jacketed ore-smelting furnace was 1,494° C. The temperature of the ore was 1,160°, and of the slag 1,288° to 1,290° ; there is considerable uncertainty about the latter, however, as one is not dealing with an absolutely "black body." In the ore-roasting process (reverberatory furnace) the temperature in the oven is generally from 800° to 900°. The temperature in the middle of a regenerative gas-furnace, reducing nickel oxide with charcoal, was 1,259°. The measurement of the temperature in the fore-hearth of a small blast-furnace was interfered with by the presence of the strongly basic slag in front of the receiver, but was probably about 1,400°. The slag in smelting concentrates had a temperature of 1,260°, and the concentrates 1,210°. After ½ hour and 1 hour's blowing in the converter the temperatures were respectively 1,116° and 1,046°. The converter was emptied after another ½ hour, the refining being then brought to an end, and the temperature was 986°. F. R.

306. *The Reactions in Lead Roasting.* **R. Schenck** and **W. Rassbach.** (Metallurgie, 4. pp. 455–468, July 8, 1907.)—The authors' experiments show that the main factor deciding the reactions taking place in the process at a given temperature is the concentration of SO_2 in the gases present. There are three fields, in which lead sulphate, pure lead oxide or oxide containing some sulphide, and lead containing some sulphide are the respective products. F. R.

307. *The Binary Systems: Silver Sulphide–Copper Sulphide, and Lead Sulphide–Copper Sulphide.* **K. Friedrich.** (Metallurgie, 4. pp. 671–678, Oct. 22, 1907. Communication from the Metallograph. u. Metallurg. Laborat. d. Kgl. Bergakademie, Freiburg.)—The determinations were made with copper sulphide containing 99·6 per cent. Cu_2S, and Ag_2S and PbS as in Abstract No. 1718 (1907). The solidification-point of Cu_2S is 1,121°. The diagram for the system: Cu_2S–Ag_2S, consists of a single curve only, having a minimum at about 667°, with about 70 per cent. Ag_2S. There is no eutectic and no maximum, hence it is concluded that one continuous series of mixed crystals occurs. In no case was the 175° transformation-point of Ag_2S encountered. In the system: PbS–Cu_2S, there is one eutectic, at about 51 per cent. Cu_2S, solidifying at 540°; and there are two series of solid solutions, but no compounds. Micrographs of this system are given. F. R.

308. *Annealing of Copper, with Special Reference to Dilatation.* **T. Turner** and **D. M. Levy.** (Roy. Soc., Proc. Ser. A. 80. pp. 1–12, Dec. 9, 1907.)—Experiments in which the dilatation of hard-drawn copper rod of 1/4-in. square section was observed up to about 580° C. show that there is no sudden change in the rate of expansion during heating or of contraction during cooling, and that there is practically no permanent change of dimensions. Upon repeating with the same bar similar results were obtained. It is concluded that neither in the case of annealed nor of worked copper is there a change upon heating or cooling which can correctly be termed "allotropic." Similar experiments on five copper alloys—(1) Cu 70, Zn 30 per cent.; (2) Cu 66, Zn 34 per cent.; (3) Cu 60, Zn 40 per cent.; (4) gun metal; (5) phosphor bronze—also gave similar results, except that the cooling curves, though regular and similar to one another, showed a slightly more rapid contraction above 400°, and less rapid contraction below 400°, than the heating curves would lead one to expect. No. (3) developed a slight twist on heating, and hence did not give satisfactory results. F. R.

309. *Formation of a Double Sulphide in the reduction of Iron Sulphides by Aluminium.* **H. Ditz.** (Metallurgie, 4. pp. 786–792, Nov. 22, 1907. Communication from the Chem.-technolog. Laborat. d. deutsch. techn. Hochschule Brünn.)—Describes experiments which indicate that in the reaction of a

mixture of an iron sulphide and Al-powder only a portion of the iron is reduced to the metallic state; the rest remains in the slag, probably as FeS in combination with the Al_2S_3 which is formed as a result of the reaction, as Al_2S_3, FeS. In the case of FeS about 3/4, and in the case of FeS_2 about 1/2 of the iron is reduced to the metallic state. F. R.

310. *Blow-holes in Steel Ingots.* **E. v. Maltitz.** (Amer. Inst. Mining Engineers, Bull. 17. pp. 691–726, Sept., 1907.)—Discusses the absorption and evolution of gases by steel when molten and during solidification. The principal points in the author's views are: (1) That the temperature of the heat during the last period of the process should be kept as low as is consistently possible; (2) avoidance of over-blowing or over-oreing, and complete blowing out of the last portion of ore added; (3) the finishing slag low in oxygen, and properly fluid; (4) assisting the reduction of ferrous oxide present by stirring the heat before tapping: (5) addition of sufficient deoxidiser in the furnace and allowing sufficient time for the resultant products to pass into the slag. F. R.

311. *Applications of the Laws of Physical Chemistry in Metallurgy of Iron.* **H. v. Jüptner.** (Iron and Steel Inst., Journ. 75. pp. 59–84, 1907. Electrochem. Ind., N.Y. 5. pp. 438–440, Nov.; 500–502, Dec., 1907; and 6. pp. 12–14, Jan., 1908. Metallurgie, 4. pp. 703–713, Nov. 8, 1907.)—Briefly resumes some recent results upon the equilibrium of some systems of interest in iron metallurgy, the particular feature being dissociation tension. These are then applied to a consideration of the events in the blast-furnace. It is shown why at the tuyère level the oxygen of the air can oxidise only the carbon and not the reduced iron, but the reaction would be affected by the presence of any FeO. Normally FeO is absent and CO only forms; its max. pressure is 0·347 atmo., neglecting the effect of any moisture in the blast. So long as the oxygen pressure of the reaction $CO_2 = CO + O$ remains higher than the tension of dissociation of FeO, CO can exercise no reducing effect on FeO, but the reduction of FeO takes place by carbon directly. The pressure of CO observed above the tuyère level exceeds 34·7 per cent.; examples are given. Much higher, however, at greater heights. If the temperature be so low that the oxygen pressure of $CO_2 = CO + O$ is below the dissociation temperature of FeO, the reduction is effected by CO. In the highest parts, Fe_3O_4 is reduced to FeO by CO. At a lower temperature, the dissociation tension of CO can be greater than that of CO_2, and $2CO = CO_2 + C$ occurs, if the dissociation pressure of the oxide of iron present is lower than that of $CO_2 = CO + O$. The latter depends on the ratio $CO : CO_2$, which is independent of pressure. If water-vapour be present in the blast, its decomposition uses up carbon; the hydrogen present decreases the partial pressure and dissociation tension of CO and CO_2, hence the action in the lower part of the furnace is detrimental. F. R.

312. *Occluded Gases in Steel.* **G. Belloc.** (Comptes Rendus, 145. pp. 1280–1283, Dec. 16, 1907.)—The relation between the rate of evolution of gas (dv/dt) and temperature (t) at which samples of turnings were heated for several days was as follows in the case of a very mild steel (carbon 0·12 and Mn 0·35 per cent.). The evolution commenced at temperatures of from 150° to 400°. dv/dt had a minimum value about 200°, and a maximum about 300°, neither of which was well marked. There was a high maximum between 500° and 600°, falling rapidly to a minimum, almost zero, with the termination

of the A_3 change. The evolution rose with the commencement of A_3, then fell, and continuously rose with further increase of temperature. Upon heating at 1,200° gas of as much as 11 to 12 times the volume of the steel was extracted. At the lower temperatures the gas is almost entirely CO_2; above 400°, H and CO; about 550°, CO_2 disappears; above 550° some N appears, but does not exceed 10 per cent. of the total gas. The distribution of occluded gas in samples from the same bar varied considerably, and the proportions of the constituent gases also varied. Experiments show the improbability of the existence of a dissociation tension of the gases occluded in the metal. [See also Abstract No. 1481 (1908).] F. R.

313. *Occluded Gases in Iron.* **O. Boudouard.** (Comptes Rendus, 145. pp. 1283–1284, Dec. 16, 1907.)—The following table shows the weight per cent. of gases extracted from merchant iron wire and bar by heating three times to 1,100°:—

Metal.	CO_2	H	CO	N	Total.
Wire 0·5 mm. diam.	0·085	0·0082	0·047	0·0105	0·0957
Wire 1 mm. diam................	0·085	0·0017	0·062	0·0042	0·1029
Plate 1 mm. thick	0·012	0·0018	0·081	0·0042	0·099
Strip cut from 1 cm.^{2} bar......	0·021	0·0056	0·18	0·0141	0·2207

Even in the third heating a considerable quantity of gas was evolved; the amount was less, the finer the state of division of the sample. It is seen that the quantities of gas are of the order of the quantities of sulphur and phosphorus commonly met with in metals of this class; and that the percentages of nitrogen are of the same order as those observed in iron and steel by Braune [see Abstract No. 747 (1907)]. The present method is too slow to be of use, however, as a direct method of estimation of nitrogen. Incidentally the author detected volatilisation of iron at 900°; it was well marked at 1,100°. F. R.

314. *Heat Treatment of Medium Carbon Steels.* **W. Campbell.** (Metallurgie, 4. pp. 772–778, Nov. 22, 1907.)—Gives the results of tensile tests and microstructure of two steels, the first containing carbon 0·50 and Mn 0·98 per cent., and the second, carbon 0·42 and Mn 0·2 per cent. The samples in the form of small bars, had been heated to a temperature of from 550° to 1,390° C. and cooled either in the air, or under lime, or very slowly in the furnace. The conclusions do not differ materially from generally accepted views. In order to refine the grain-size of steels of this class they should be heated to Ac_{2-3}, about 750°. The coarser the grain initially, the higher the temperature of this heating must be. The lower the carbon and Mn contents, the higher this temperature. The limits are ordinarily between 735° and 785°. After heating above Ac_1 (710°), air-cooled samples had a greater tensile strength than those cooled in the furnace, and, in some cases, than the original material. The elongation, however, tends to be less with the more rapid than with the slow cooling. F. R.

315. *Solubility of Graphite in Iron.* **G. Charpy.** (Comptes Rendus, 145. pp. 1277–1279, Dec. 16, 1907.)—A grey iron, made by melting a Swedish iron cemented by wood charcoal, slowly cooled, contained 3·75 per cent. total carbon, 3·34 per cent. being graphite, and less than 0·1 per cent. of Si and Mn. Upon heating to various temperatures (for 6 to 7 hours when below 900° C., and for 8 hours at higher temperatures), and then quenching, the percentages of combined carbon were as follows :—

Annealing temperature...	750° C.	850°	1,000°	1,050°	1,080°	1,100°	1,150°
Combined carbon, per cent.	0·31	0·85	1·08	1·36	1·44	1·40	2·47

On heating a white iron of similar total composition to 1,150°, cooling slowly to 1,000° and quenching, the sample contained 0·92 per cent. combined carbon. Upon cooling a similar sample slowly from fusion to 1,000° and quenching, the product contained 0·95 per cent. combined carbon. Upon cementing iron at 1,000° in wood charcoal, samples were obtained containing 1·10 and 0·89 per cent. of combined carbon respectively. The general conclusions to be drawn from these results are that the solubility of graphite in iron increases regularly with temperature, and that the solubility at 1,000° must be about 1 per cent. F. R.

316. *Dependence of Elastic Properties of Steel upon Composition and Treatment.* **Wawrzinirk.** (Metallurgie, 4. pp. 810–815, Dec. 8, 1907.)—Complete tensile test results are given for a series of carbon steels containing from 0·63 to 1·13 per cent. carbon, but otherwise similar in composition. The modulus of elasticity decreases with increasing carbon from about 2,098,000 with 0·63 per cent. carbon to 2,121,000 with 1·13 per cent. carbon, in kg./cm.². The effect of annealing at various temperatures from 450° to 1,160° C. appears to be somewhat uncertain, but there is a tendency to low values after annealing at 500°, and to higher values after annealing at 600° or 700°. The variation of the other mechanical properties is in fair agreement with well-known results. The results of similar tests upon three chromium steels [carbon 0·95, 1·18, and 1·70, and Cr 0·60, 0·66, and 0·97 per cent. respectively] are given. The elastic limit, tensile strength, and elongation were materially lowered, and the modulus of elasticity slightly raised by annealing. Brief reference is made to the microstructure of the series. F. R.

317. *Metallography of the High-Carbon-Iron Alloys.* **P. Goerens.** (Stahl u. Eisen, 27. pp. 1776–1778, Dec. 4, 1907.)—Goerens points out that in his paper [see Abstract No. 912 (1907)] referred to by Heyn [Abstract No. 154 (1908)] he called attention to the great difference between the solidification-point and melting-point of grey iron, whilst in white iron these two points are practically at the same temperature. On this ground Goerens had founded certain theories, and Heyn had founded similar theories merely on the well-known difference between the melting-points of white and grey iron. Goerens illustrates his explanation of the ejection of "kish," as due to the great difference between the specific gravities of the solid graphite and molten metal, by an experiment in which small sticks of wood are released under mercury, and jump quite clear of the surface. **E. Heyn,** however, does not accept this as absolutely satisfactory, as the graphite occurs actually in small flakes, not rods; and further, Goerens' experiment fails unless the sticks are released nearly or quite vertically. F. R.

318. *Case-hardening of Iron and Steel.* (Brit. Pat. 19,498 of 1906. Engineer, 104. p. 355, Oct. 4, 1907. Abstract.)—W. R. Hodgkinson claims the carburisation of iron and mild steel by heating in a mixture of acetylene and ammonia gases (about 1 : 2 by volume). This mixture may be prepared by adding calcium carbide to ammonium chloride in the heated chamber in which the pieces are to be treated. Acetylene alone will carburise steel, but in the presence of NH_3 mere decomposition of much of the acetylene is obviated. It is probable that cyanogen is formed and afterwards decomposed, as the steel after treatment contains nitrogen. A 3 or 4 hours' exposure at 860° C. has about the same effect as 10 min. at 1,000° C. A ½-in. square bar containing 0·04 per cent. carbon, exposed for 30 min. at 500° to 600°, is stated to be "carburised to the hardness of steel containing about 1 per cent. carbon." F. R.

319. *Heterogeneous Catalytic Reactions.* IV. *Kinetics of the Contact Process for Sulphuric Acid.* **M. Bodenstein** and **C. G. Fink.** (Zeitschr. Phys. Chem. 60. pp. 1–45, July 28, 1907. Physikal.-Chem. Inst. d. Univ., Berlin u. Leipzig.)—The results obtained by the authors indicate that the velocity with which sulphur dioxide and oxygen react, when they have come into contact with smooth Pt, is very great. The measured velocity of the reaction is controlled by the velocity with which the SO_2 diffuses through a layer of SO_3 adsorbed by the Pt. The influence exerted on the reaction by foreign gases —CO_2 and nitrogen—and also the temperature-coefficient of the reaction are in agreement with this theory. T. H. P.

320. *Heterogeneous Catalytic Reactions.* V. *General Considerations.* **M. Bodenstein** and **C. G. Fink.** (Zeitschr. Phys. Chem. 60. pp. 46–69, July 28, 1907. Physikal.-Chem. Inst. d. Univ., Berlin u. Leipzig.)—The formation of sulphur trioxide from the dioxide and oxygen follows the law given in the preceding Abstract for catalysis with platinum when the latter is replaced by vanadium pentoxide [Abstract No. 684 (1905)], or arsenic pentoxide [Abstract No. 1538 (1905)]. In all cases, the reaction velocity is that with which the sulphur dioxide diffuses through a layer of adsorbed trioxide. T. H. P.

321. *Ammonia Equilibrium.* **W. Nernst.** (Zeitschr. Elektrochem. 13. pp. 521–522; Discussion, pp. 523–524, Aug. 9, 1907. Paper read before the 14. Hauptversamml. d. Deutsch. Bunsen-Gesell., Hamburg, May 12, 1907.)—Haber and van Oordt [Abstract No. 1165 (1905)] obtained values for the partial pressure of ammonia in equilibrium with nitrogen and hydrogen in the proportions $2NH_3$, N_2, $3H_2$, at 1,000°, much lower than those indicated by the author's theory [Abstract No. 1141 (1906)]. New measurements at pressures of 50–70 atmospheres, with which the yield of ammonia is considerably higher than with ordinary pressures, give values for the partial pressure of ammonia in good accord with the above-mentioned theory, so that Haber and van Oordt's numbers are too high. During the discussion of this paper, **Haber** stated that he and Le Rossignol had recently obtained results similar to those given by the author. T. H. P.

322. *Synthesis of Ammonia by the aid of Catalysers.* **L. Brunel** and **P. Woog.** (Comptes Rendus, 145. pp. 922–924, Nov. 25, 1907.)—Pure nitrogen is prepared by passing air over glowing copper, and pure hydrogen from zinc and HCl. The gases are mixed in the proportion 1:3 and passed

over the catalysers at various temperatures. Mixtures of the oxides of thorium and cerium, further the oxides of Ca, Ba, Sr, MnO_2, calcium molybdate, aluminium phosphate, spongy Pt and Pd did not give any ammonia at temperatures ranging from 15 to 350°. Finely-divided carbon (reduced from toluene) was likewise ineffective between 170 and 285°; when this carbon was exposed to a current of air, some carbon was burned, and a little ammonia was formed. Nickel oxide also gives traces of ammonia; in a mixture of hydrogen and air the oxide is alternately reduced and oxidised, when much heat is liberated, and water and a little ammonia are formed; the incandescence destroys the ammonia again, however, and the yields are poor even with cooling. H. B.

323. *Polarimetric Investigations.* III. **C. Winther.** (Zeitschr. Phys. Chem. 60. pp. 563–589, Oct. 1, 1907. Chem. Universitätslaborat., Kopenhagen, June, 1907.)—The rotatory dispersion of nicotine is almost independent of the solvent and concentration, but the actual rotatory power is considerably affected in certain cases. In ethyl alcohol the specific rotation is reduced (from —164°) to —140°, in methyl alcohol to —130·5°, and in water to —75°; to this list of solvents is now added formamide, which reduces the rotatory power (in an 11 per cent. solution) to —78·7°. Ethylene bromide was found to have the unique property of raising the rotatory power to —180° in a 10 per cent. solution. The rotatory dispersion of camphor is somewhat greater than that of nicotine, and is again but little dependent on the solvent and concentration: in this case also the actual rotation, which is diminished by other solvents, is increased by ethylene bromide. In the case of ethyl tartrate the use of formamide gives a maximum *dextro*rotation ranging from +25° in the red to +48° in the dark blue: formamide, on the other hand, in dilute (2·8 per cent.) solution, gives a maximum *lævo*rotation ranging from —12° in the red to —46° in the dark blue. Water, methyl alcohol, ethyl alcohol, pure ethyl tartrate, isobutyl alcohol and chloroform give intermediate rotatory powers, and when the specific rotations are plotted against wave-length the whole 23 curves for these solvents form a continuous family of curves, which are often close together but never intersect. The theoretical discussion of these results is postponed to a later paper. The molecular depression of the freezing-point of formamide has the extraordinary value 3,200. T. M. L.

324. *Influence of Non-Electrolytes and Electrolytes on the Solubility of Gases in Water.* **J. C. Philip.** (Faraday Soc., Trans. 3. pp. 140–145, Oct., 1907. Electrician, 59. pp. 596–597, July 26, 1907. Abstract.)—The solubility of hydrogen in water appears to be diminished by the addition of chloral hydrate; thus 1 litre of pure water dissolves 18·83 c.cm., and 1 litre of 29·5 per cent. solution dissolves 15·42 c.cm. This effect disappears, however, if the calculation be made in such a way as to give the volume of gas dissolved per 1,000 gm. of water independently of the chloral hydrate added; the solubility then remains constant up to 30 per cent. $CCl_3 . CH(OH)_2$, at 18·9 per cent. In the case of cane-sugar this correction does not give a constant solubility of hydrogen in water unless a further assumption is made that *the cane-sugar is combined with six molecular proportions of water* which are thus rendered inert so far as the dissolution of hydrogen is concerned. If a similar assumption (that the volume of hydrogen dissolved is a measure of the "free" water in the solution) be made in the case of potassium chloride, Steiner's measurements of the solubility of hydrogen at 15° give an average molecular hydration of about $9H_2O$, whilst Knopp's measurements at 20° give an average value about $10H_2O$. The solubility of hydrogen in other salt solutions leads to the following values for the average molecular hydration. $NaCl + 11H_2O$, $NaNO_3 + 9{\cdot}8H_2O$, $Na_2SO_4 + 28{\cdot}5H_2O$, $Na_2CO_3 + 31H_2O$, $KNO_3 + 8H_2O$, $K_2CO_3 + 30H_2O$, $LiCl + 8H_2O$, $CaCl_2 + 21H_2O$, $MgSO_4 + 25H_2O$, whilst measurements of the solubility of oxygen gives the values $NaCl + 14{\cdot}7H_2O$, $K_2SO_4 + 37H_2O$, $H_2SO_4 + 11H_2O$, $HCl + 4{\cdot}4H_2O$, $HNO_3 + 2{\cdot}5H_2O$, $NaOH + 20{\cdot}5H_2O$ $19{\cdot}5H_2O$. These values agree very fairly with the values deduced by other methods by Bousfield and by Caldwell, but differ considerably from the values deduced by Jones; the latter made his measurements at the freezing-point and used a method involving more assumptions than that now described, which appears actually to give reliable information in reference to the hydration of salts in solution. Other gases and solids might be used for the same purpose, but the values obtained are less trustworthy, *e.g.*, phenylthiocarbamide is more soluble in ammonium nitrate than in water, and would give a negative value for the hydration of this salt.

T. M. L.

325. *Gas Solubility, Compressibility and Surface Tension.* **A. Ritzel.** (Zeitschr. Phys. Chem. 60. pp. 319–358, Aug. 6, 1907.)—The author measures the compressibility and surface tension of various mixtures of different pairs of organic liquids, and also the dilatation accompanying the absorption of CO by different mixtures. Comparison of the solubility of CO in binary mixtures of organic liquids [compare Skirrow, Abstract No. 131 (1903)] with the compressibility of the same mixtures, shows that the solubility-concentration and compressibility-concentration curves are similar in form in all cases. Maxima or minima of the solubility-concentration curve correspond with minima of the capillarity-concentration curve. The capacity of a liquid to dissolve a sparingly soluble gas evidently stands in close relation to its compressibility and, making certain assumptions, the author deduces the formula, $\lambda = P\beta/\delta$, where λ is the solubility of the gas, β the compressibility of the solvent, δ the absorption-dilatation coefficient, and P the solubility pressure, giving a measure of the tendency of the gas to dissolve in the liquid. The probable validity of this formula is supported by evidence from various sources.

T. H. P.

326. *Bose's Calorimetric Studies.* **A. Winkelmann.** (Zeitschr. Phys. Chem. 60. pp. 626–638, Oct. 1, 1907.)—Bose's determinations of the heats of mixture of ethyl alcohol and water [see Abstract No. 434 (1907)] are here compared with those made by the author in 1873. The agreement is satisfactory, and more especially when the author's results are recalculated with avoidance of the hypothesis formerly introduced, viz., that the ratio of the specific heat of a mixture at any temperature to the sum of the specific heats of its unmixed components at the same temperature is independent of the temperature.

R. E. B.

327. *Heats of Combustion and of Formation of Gaseous Hydrogen Phosphide.* **P. Lemoult.** (Comptes Rendus, 145. pp. 374–376, Aug. 5, 1907.)—The molecular heat of combustion of gaseous hydrogen phosphide is found, by means of the calorimetric bomb, to be 310 cals. at constant volume, and 311·2 cals. at constant pressure. The heat of formation is expressed by: $P\,(\text{white, sol.}) + H_3(\text{gas}) = PH_3(\text{gas}) - 5{\cdot}8$ cals; a value which is in accord with the feeble stability of the gas.

T. H. P.

328. *Electrical Conductivity of Solutions in Ethylamine.* **F. L. Shinn.** (Journ. Phys. Chem. 11. pp. 537–541, Oct., 1907.)—Measurements were made of the conductivity at 0° of solutions in ethylamine (b.p. 19° C.) of silver nitrate, lithium chloride, and ammonium chloride. The molecular conductivity of the silver nitrate (which was about 10 times as great as in amylamine) was found to decrease as the solution was diluted to about N/80 and then to increase slightly [compare Franklin and Gibbs, Abstract No. 332 (1908)]. In the case of lithium chloride there is a maximum molecular conductivity at 0·8 N. T. M. L.

329. *Conductivities of Molten Salts.* **K. Arndt.** (Zeitschr. Elektrochem. 13. pp. 509–510; Discussion, pp. 510–511, Aug. 9, 1907. Paper read before the 14. Hauptversamml. der Deutsch. Bunsen-Gesell., Hamburg, May 12, 1907.)—Using the method previously given [Abstract No. 1129 (1906)], the author determines the conductivity of the fused bromides and iodides of potassium, sodium and silver and of silver chloride. The chlorides conduct better than the bromides and these better than the iodides, and the conductivity of the sodium salts is 1·5 times that of the potassium salts. The conductivity of all salts with monovalent anions and kathions increases proportionally with the temperature, whilst with salts containing divalent kathions, for instance calcium chloride, the temperature coefficient of the conductivity is smaller at higher temperatures. For mixtures of potassium and sodium chlorides or of calcium and strontium chlorides, the conductivity is additively related to those of the constituent salts. The use of boric anhydride as a convenient solvent for dissociation calculations is referred to [see Abstract No. 1739 (1907)]. T. H. P.

330. *Conductivity of Hydrochloric and Nitric Acids in Aqueous Solutions.* **P. Bogdan.** (Zeitschr. Elektrochem. 13. pp. 596–598, Aug. 30, 1907. Laborat. f. molekuläre Physik, Akustik and Optik, Jassy.)—From the results of measurements of the electrical conductivity of dilute solutions of hydrochloric and nitric acids, the author concludes that the usually accepted values of λ_∞ are too high, the values found being 369·6 for hydrochloric and 366·8 for nitric acid at 18°. These two acids obey the Ostwald dilution formula for concentrations less than N/80. The dissociation constants are 0·85 and 0·86 for nitric and hydrochloric acids respectively. T. H. P.

331. *Conductivity of Dilute Acids.* **F. Kohlrausch.** (Zeitschr. Elektrochem. 13. pp. 645–646, Sept. 27, 1907.)—Bogdan [see preceding Abstract] states that, in dilute solution, hydrochloric and nitric acids obey Ostwald's dilution law. The author challenges this result, since the numbers given by Bogdan conform equally well to the author's formula [Abstract No. 1733 (1907)], which holds for concentrations five times as great as those given by Bogdan. A decision on this point can only be obtained when it becomes possible to investigate the acids in pure water. T. H. P.

332. *Electrical Conductivity of Methylamine Solutions.* **E. C. Franklin** and **H. D. Gibbs.** (Amer. Chem. Soc., Journ. 29. 1389–1396, Oct., 1907.)—Methylamine, which has somewhat wide solvent properties, is also a good electrolytic solvent. The molecular conductivity of silver nitrate in this solvent changes with dilution in a somewhat remarkable manner: after increasing in the normal way for a short period it reaches a maximum value, then falls to a minimum, after which it again increases in the normal way to a limiting value at high dilution. Potassium iodide and nitro benzenesulphonamide give very similar curves, but owing to limited solubility only the minimum and not the maximum can be observed; on the other hand, Kahlenberg and Ruhoff, working with silver nitrate in piperidine, and Lewis working with potassium iodide in liquid iodine, have observed the maximum but not the minimum; there is, therefore, good reason to think that the curve now plotted is a general type and that the maxima and minima quoted above, as well as the observations of Kablukoff, Euler, MacIntosh and Archibald, Frankland and Kraus, &c., represent different portions of the general curve. In explanation of these results the authors suggest that the conductivity in concentrated solutions is mainly autolytic, as in fused salts, whilst in dilute solutions it is heterolytic, as in the case of other composite electrolytes. The effect of dilution is to decrease the viscosity of the solution, to diminish the aut-ionisation and ultimately to increase the ionisation due to the solvent: in this way the looped shape of the curve can be explained. T. M. L.

333. *Studies of the Processes Operative in Solutions.* Parts II.–V. **H. E. Armstrong** [with **J. V. Eyre, A. V. Hussey, W. P. Paddison, R. Whymper, J. A. Watson, R. J. Caldwell**]. (Roy. Soc., Proc. Ser. A. 79. pp. 564–597, Sept. 27, 1907.)—II. *Displacement of Chlorides from Solution by Alcohol and by Hydrogen Chloride* [with J. V. Eyre, A. V. Hussey, and W. P. Paddison].—If the assumption be made that the solubility of chlorides in water is diminished by adding alcohol or HCl owing to the elimination of water in the form of hydrates by the added substance, it is possible to deduce from the measured solubilities values for the average molecular hydration of these substances. The values obtained vary with the chloride that is used, indicating the existence of competition for the solvent between the chloride on the one hand and the alcohol or hydrogen chloride on the other. Thus in the case of alcohol the average hydration ranges from 2·84 to 8·20 in presence of NaCl, from 8·10 to 8·75 in presence of KCl, from —0·64 to 1·88 in presence of NH_4Cl, from 1·40 to 8·18 in presence of KBr, and from 0·97 to 1·47 in presence of KI. The hydration of HCl varies from 6·88 to 7·85 in presence of NH_4Cl, from 8·84 to 12·56 in presence of NaCl, and from 8·42 to 18·02 in presence of KCl. The chief conclusion arrived at is that "the condition of the salts in highly concentrated solutions is peculiar and different from that which they assume in presence of a considerable proportion of the precipitant," and that "the easily precipitable form of potassium and sodium chlorides is a complex polymerised molecule, closely related perhaps to the solid form." The anomalous behaviour of ammonium chloride is associated in part with the low melting-point of this salt. III. *Sucroclastic Action of Nitric Acid as Influenced by Nitrates* [with R. Whymper].—The inversion of cane-sugar by nitric acid is accelerated in presence of nitrates. This result may be attributed to the removal of water from the solution by the metallic nitrate and a consequent concentration of the acid. The numerical results are given below. IV. *Hydrolysis of Methyl Acetate in presence of Salts* [with J. A. Watson].—Mineral chlorides and nitrates cause an acceleration in the rate of hydrolysis of methyl acetate by hydrogen chloride and nitrate. This may be attributed as in the previous case to the dehydrating effect of the salt; the effects are, however, less than in the case of cane-sugar, and it is suggested that the salts also have a direct retarding effect owing to combination with the acetate. V. *Discrimination of Hydrates in Solution* [with R. J. Caldwell].—The following table gives the values for the average molecular hydration of dissolved salts as deduced by the solubility method [compare Philip, Abstract No. 824 (1908)] and by the hydrolytic methods described in the present series of papers. The general concordance of the results appears to indicate that these two methods do actually yield reliable information as to the hydration of the salts in question.

AVERAGE HYDRATION OF SALTS IN SOLUTIONS OF GM.-MOLECULAR STRENGTH.

Criterion.	Hydrolysis.		Solubility.								
	Cane-sugar.	Methyl, acetate.	Hydrogen.					Oxygen.	Nitrous Oxide.		
Observers ...	Caldwell & Whymper.	Watson.	Gordon.	Steiner.	Geffcken.	Braun.	Knopp.	Geffcken.	Roth.	Geffcken.	Knopp.
Temperature	25°	25°	15°	15°	25°	25°	20°	25°	25°	25°	20°
$CaCl_2$ ...	22	20	19·1	19·8							
$BaCl_2$ ...	19	18	—	—	—	27·0	—	—	—	—	—
NaCl ...	18	10	11·2	11·2	—	10·5	—	14·0	12·0	—	—
KCl	10	8	9·9	10·1	—	—	10	—	—	—	—
LiCl	—	—	8·5	8·8	—	—	—	—	—	9·4	
NH_4Cl ...	10	5	—	—	—	—	—	—	—	4·2	—
KBr	—	—	—	—	—	—	—	—	—	8·8	—
$Sr(NO_3)_2$	18										
$NaNO_3$...	11	3	9·5	10·1	—	—	11	—	—	—	10
KNO_3 ...	8	1	9·2	9·0	—	—	7	—	—	—	7
$LiNO_3$ ...	18	0	—	—	—	—	—	—	—	—	—
NH_4NO_3	7	—ve	—	—	—	—	2	—	—	—	—
$AgNO_3$...	5	—	—	—	—	—	—	—	—	—	—
NaOH ...	—	—	—	—	16·0	—	—	19·5			
KOH ...	—	—	—	—	14·0	—	—	18·0	—	14·0	
H_3PO_4 ...	—	—	—	—	—	—	—	—	4·4		
HCl	—	—	—	—	2·6	—	—	2·7	—	1·4	—
HNO_3 ...	—	—	—	—	1·4	—	—	0·9	—	—ve	—

Attention is called to the importance of hydration as a determining factor in electrolysis, and in the case of aqueous potassium chloride a mechanism of electrolysis is suggested analogous to Grotthus' chain hypothesis but involving the presence in the chain of molecules, both of the solvent and of the solute.

T. M. L.

334. *Electrical Conductivity of Solutions of the Organic Acids in Liquid Hydrogen Chloride and Bromide.* **E. H. Archibald.** (Amer. Chem. Soc., Journ. 29. pp. 1416–1439, Oct., 1907.)—The monobasic organic acids, both fatty and aromatic, dissolve in hydrogen chloride and bromide to form conducting solutions, the only exception noticed being formic acid, which did not give conducting solutions when dissolved in HBr ; the polybasic acids, with a few exceptions, such as fumaric and racemic acids, do not give conducting solutions. The molecular conductivity for the hydrogen bromide solutions (with the exception of the more dilute solutions of salicylic acid) decreases rapidly with increasing dilution; this is also true for all the more concentrated solutions in HCl, but at greater dilutions the molecular conductivity usually increases with the dilution, especially in the case of the solutions of higher conductivity. The temperature-coefficients are all positive, though they vary greatly in magnitude; the coefficients are greatest in concentrated solutions. T. M. L.

335. *Optical Rotations, Electrical Conductivities and Densities of Aqueous Mixtures of Sodium-Potassium Tartrate and Ammonium Molybdate.* **J. R. Milne.** (Roy. Soc. Edinburgh, Proc. 27. pp. 271–280, 1907.)—The rotatory dispersion of the original N/8 tartrate solution is governed by the law (Rotation) × (Wave-length)^2 = a constant; in presence of the molybdate not only is the actual rotation greatly increased, but the rotatory dispersion is increased up to $\frac{3}{4}$N molybdate, though at normal concentration the product $R \times \lambda^2$ decreases with decreasing wave-length. The curves connecting rotation with wave-length are normal in character, but anomalous curves are obtained in all cases in which the concentration of the molybdate is plotted against the physical properties (conductivity, density, specific rotation or rotatory-dispersion) of the solution. T. M. L.

336. *Heat of Formation of the System H_2SO_4, H_2O.* **R. Kremann** and **F. Kerschbaum.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2b. pp. 813–818, May, 1907. From the Chem. Inst. d. Univ., Graz.)—The heat liberated on mixing equivalent quantities of sulphuric acid and water is 69 cals. per gm. of mixture. It was expected that when the hydrate $H_2SO_4H_2O$ was heated it would show an abnormal heat absorption owing to the dissociation of the compound into its constituents. This was found not to be the case, the specific heat of the hydrate between 0° and 207° being slightly less than that calculated from the values of the two constituents. The conclusion is drawn that the heat liberated on mixing the acid and water is due, not to the chemical change involved in the formation of a hydrate, but to physical changes accompanying the admixture. In view of the fact that both sulphuric acid and water dissociate when heated, it is doubtful whether this conclusion is justified. T. M. L.

337. *Existence of Molecular-compounds and Hydrates in the Liquid State.* **R. Kremann** and **R. Ehrlich.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2b. pp. 733–794, May, 1907. From the Chem. Inst. d. Univ., Graz.)—The formation of molecular compounds, such as H_2SO_4 and H_2O is usually accompanied by a contraction in volume. As the compounds dissociate when heated the ordinary thermal expansion is augmented by an expansion due to the dissociation of the molecular compound: the coefficient of expansion is therefore abnormally high, over the range of temperature in which dissociation takes place, and is at a maximum when the two constituents are present in molecular proportions. By applying this method of investigation it was found that the hydrate $H_2SO_4 + H_2O$ is still undergoing dissociation at the highest temperature, 88°, at which measurements were made. In the case of $C_6H_5OH + C_6H_5NH_2$ the coefficient of expansion was normal, probably owing to a very small change of volume in the formation of the molecular compound (cf. $Na_2SO_4 + 10H_2O$); actually a contraction of 0·48 per cent. occurs

when equivalent quantities of aniline and phenol are mixed at 35°, at 62°, or at 33°, but this cannot be due to the formation of the molecular compound, since this is known to be completely dissociated at 33°, and is attributed to physical (?) changes accompanying the formation of a liquid mixture. The admixture of equivalents of water and 100 per cent. H_2SO_4 is accompanied by a contraction of 8·41 per cent. at 0° and 7·24 per cent. at 38·1°; in this case the hydrate probably persists up to 130°, but even at this temperature there would probably still be a contraction of nearly 7 per cent. Aniline and nitrobenzene, which do not form a compound, expand slightly when mixed, but have a constant coefficient of expansion up to 80°. The formation of liquid molecular compounds can be detected by measurements of molecular surface energy (which is normally an additive property), but this method is inapplicable in the case of hydrates owing to the complex behaviour of water, apart from the addition of a second substance. A much more efficient method, however, consists in the study of the viscosity of liquid mixtures; if these show a maximum viscosity at an intermediate concentration it is nearly certain that a molecular compound is present in the liquid. The maximum may occur with equimolecular proportions, as in the case of $H_2SO_4 + H_2O$, but this need not be the case, especially if the two components are of widely different viscosity (phenol or *m*-cresol mixed with aniline). At higher temperatures, as the molecular compound decomposes, the maximum disappears; this is the case for phenol and *m*-cresol with aniline at 60–70°, and for $H_2SO_4 + H_2O$ at 130°, and it is assumed that above these temperatures the dissociation of the compound is complete. T. M. L.

338. *Molecular Aggregation in Solution as exemplified in Aqueous Mixtures of Sulphuric Acid with Inorganic Sulphates.* **J. Holmes** and **P. J. Sageman.** (Chem. Soc., Journ. 91. pp. 1606–1619, Sept., 1907.)—Although a contraction (reaching a maximum value at intermediate concentrations) occurs on mixing water with acetone (largest effect), acetic acid, ethyl alcohol, methyl alcohol, pyridine, and formic acid (smallest effect), an expansion occurs when aqueous solutions of sulphuric acid are mixed with aqueous solutions of mineral sulphates. The effects produced reach a maximum at intermediate concentrations, and decrease in the series K_2SO_4, Na_2SO_4, $(NH_4)_2SO_4$, $MgSO_4$, $ZnSO_4$, $\frac{1}{3}Al_2(SO_4)_3$, $CuSO_4$. The view is adopted that the general concordance of the curves gives strong support to the view that "the increases in volume are due to physical forces of repulsion between the molecules rather than to the formation of acid sulphates in solution." The authors add that their method of interpreting volumetric solutions is antagonistic to the existence of hydrates in solutions of inorganic salts, since the neutral anhydrous sulphates of potassium and ammonium give with sulphuric acid a maximum expansion in the same molecular mixtures as the variably hydrated sulphates of copper, sodium, &c. T. M. L.

339. *Fused Hydrated Salts as Cryoscopic Solvents.* **J. L. R. Morgan** and **H. K. Benson.** (Zeitschr. Anorg. Chem. 55. 3. pp. 261–270, Sept. 11, 1907. Extract of Dissertation, Columbia Univ., 1907.)—The solvents used were $CaCl_2,6H_2O$ (m.p. 29·48°, $\Delta = 45·0$), $LiNO_3 . 3H_2O$ (m.p. 29·88, $\Delta = 26·0$), and $Na_2C_2O_4,10H_2O$ (m.p. 19·92°, $\Delta = 38·5$). The latent heat of fusion of the nitrate was calculated from the cryoscopic data to be 70·6 gm.-cals. per gm. Acetic acid and alcohol show in the two former solvents molecular weights increasing with the concentration; this probably corresponds with the heat absorption which occurs on dilution. T. M. L.

340. *Velocity of Dissolution of Solids.* II. **M. L. Bruner** and **S. Tolloczko.** (Acad. Sci. Cracovie, Bull. 7. pp. 672–690, July, 1907. Zeitschr. Anorg. Chem. 56. 1. pp. 58–71, Oct. 28, 1907. Abstract.)—Previous observations on the velocity of dissolution of sparingly soluble substances [Abstract No. 3297 (1904)] are now extended to readily soluble substances; for this purpose natural crystals of rock-salt were used, and were found to be more advantageous than artificial crystals of chrome alum or copper sulphate. It was found that the influence of velocity of flow on the rate of dissolution could be expressed more accurately by the formula of Noyes and Whitney than by the formula of Schürr. The diffusion-constant was calculated at 1·710 for NaCl, as compared with 0·214 for $CaSO_4,2H_2O$ (alabaster). No marked difference could be detected in the rate of dissolution of plates of rock-salt cut parallel to the cube, octahedron, and dodecahedron faces. T. M. L

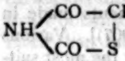
341. *Boiling- and Freezing-points of Concentrated Aqueous Solutions: Hydration of the Solute.* **S. M. Johnston.** (Roy. Soc. Edinburgh, Trans. 45. 32. pp. 855–884, 1907.)—Boiling-point and conductivity measurements are given in the case of concentrated solutions of ammonium chloride and bromide, sodium chloride, bromide, and iodide, barium chloride and bromide, strontium bromide, calcium chloride and bromide, lithium chloride, bromide, iodide, and sulphate, magnesium and zinc sulphates. Freezing-point and conductivity measurements are given for hydrochloric and nitric acids, calcium and lithium chlorides, and ammonium nitrate. From these data the proportions of free and of combined water are deduced, and values are calculated for the average molecular hydration on the assumptions that (1) the whole of the salt is hydrated, (2) the ionised part only is hydrated, and (3) the un-ionised part only is hydrated. The second assumption is exceedingly improbable, as it led in several cases to the conclusion that the ions become more and more hydrated as the proportion of water becomes less and less. In the case of the ammonium salts, where the hydration is exceedingly small, it is considered possible that only the ions are hydrated. In the case of zinc and magnesium sulphates there is evidence that the molecules associate or enter into combination with each other. T. M. L.

342. *Dissociation of Hydrogen Sulphide.* **G. Preuner.** (Zeitschr. Anorg. Chem. 55. 3. pp. 279–288, Sept. 11, 1907.)—By investigating the equilibrium $2H_2 + S_2 \rightleftarrows 2H_2S$, by Löwenstein's method [Abstract No. 984 (1906)], the author is enabled to determine the heat effect consequent on the transformation of solid sulphur into gaseous S_2 molecules. The results obtained are expressed by the following equations:—

$$2H_2S(\text{gas}) = 2H_2S(\text{gas}) + S_2(\text{gas}) - 39{,}400 \text{ cals.};$$
$$2H_2(\text{gas}) + 2S(\text{solid}) = 2H_2S(\text{gas}) + 5{,}400 \text{ cals.};$$
$$2S(\text{solid}) = S_2(\text{gas}) - 34{,}000 \text{ cals.};$$
$$S_8(\text{gas}) = 4S_2(\text{gas}) - 43{,}200 \text{ cals.}$$

T. H. P.

343. *Dissociation as measured by Freezing-point Lowering and by Conductivity.* **H. C. Jones** and **J. N. Pearce.** (Amer. Chem. Journ. 38. pp. 683–748, Dec., 1907.)—Measurements have been made of the freezing-points and conductivities at 0° C. of aqueous solutions of fifteen salts and three strong acids. In the case of every salt it has been found that the dissociation in the dilute solution, as measured by the conductivity method, is *less* than that calculated from the freezing-point lowering. It is only in case of those salts which crystallise in the anhydrous condition that comparable values are obtained by the two methods; these values are found only at those concentrations in the neighbourhood of which the minimum molecular lowering occurs. T. M. L.

344. *Ionisation of Water at 0°, 18°, and 25°, derived from Conductivity Measurements.* **C. W. Kanolt.** (Amer. Chem. Soc., Journ. 29. pp. 1402–1416, Oct., 1907. Contribution from the Research Lab. of Phys. Chem., Mass. Inst. of Technology, No. 19.)—Conductivity measurements were made at 0°, 18°, and 25° of ammonium hydroxide, of diketotetrahydrothiazole , and of the salt formed by their combination. The ionisation constants were found to be as follows:—

	Am. Hydroxide.	Thiazole.	Water.
0°.........	$13·91 \times 10^{-6}$	$0·0711 \times 10^{-6}$	$0·089 \times 10^{-14}$
18°.........	$17·15 \times 10^{-6}$	$0·146 \times 10^{-6}$	$0·46 \times 10^{-14}$
25°.........	$18·06 \times 10^{-6}$	$0·181 \times 10^{-6}$	$0·82 \times 10^{-14}$

The values deduced for the concentrations of the hydrogen ions, $0·30 \times 10^{-7}$ at 0°, $0·68 \times 10^{-7}$ at 18°, and $0·91 \times 10^{-7}$ at 25°, are 16 to 20 per cent. lower than those derived by Kohlrausch and Heydweiller from the conductivity of the purest water. From their variation with the temperature the heat of ionisation of water was calculated and found to be in close agreement with the value obtained experimentally by the neutralisation of strong acids and bases. T. M. L.

345. *The Nature of Ueberspannung* [*Supertension*]. **E. Müller.** (Zeitschr. Elektrochem. 13. pp. 681–684, Oct. 18, 1907.)—The author disputes Kaufler's conclusion [see Abstract No. 1976 (1907)] that we need not believe in any oxygen pressures of thousands of atmospheres at electrodes under supertension. Certain chemical compounds, notably such with anions rich in oxygen, must contain the oxygen under high pressures; for they voluntarily part with their oxygen again. These compounds could electrolytically only be prepared with the aid of supertension; the oxygen pressure need not be a physical pressure, but might be a kind of chemical compression. The author further questions the experiments. In some cases the potential relations in cold acid were assumed to hold for warm acid; oxidations of chromisulphate to chromic acid, of iodic acid to periodic acid, and of sulphuric acid to persulphuric acid should be impossible, according to Kaufler, whose argument—that an electrode was the warmer the higher its potential—finally meant that a Pt electrode would become cooler by being heated; for, with Pt at any rate, the potential diminishes on heating. H. B.

346. *Current Efficiency of an Electrolytic Cell.* **W. R. Mott.** (Amer. Electrochem. Soc., Trans. 11. pp. 195–204; Discussion, pp. 204–209, 1907.)—The author gives a theoretical discussion of the subject of current efficiency. Three cases are discussed, showing the losses in current efficiency as they originate at different current densities. The anode and kathode processes are treated separately, it being stated that current efficiency of the cell

as a whole is without meaning, since the anode and kathode reactions are independent. A theoretical interpretation, which is intended to be more suggestive than conclusive, is given to the ordinary forms of current efficiency curves. No novelty is claimed for these interpretations, unless it be the plea that all reactions at surfaces should be expressed in terms of current densities. Attention is called to an electrochemical method of measuring rates of chemical reaction by observations on the voltage-current curves. In the *discussion* **Bancroft** subjected the paper to a very adverse criticism.

T. S. P.

347. *New Results in Electro-analysis.* **T. P. McCutcheon, Jr.** (Amer. Chem. Soc., Journ. 29. pp. 1445–1455, Oct., 1907. Contribution from the John Harrison Lab. of Chemistry.)—The author describes experiments made in continuation of those of Hildebrand [Abstract No. 1266 (1907)]. Various metals were employed for the anode, silver being apparently the most suitable for receiving most anions. Amalgams of Li, Na, K, Ca, Sr, and Ba decompose in the outer compartment of Hildebrand's cell (*loc. cit.*), with formation of the corresponding hydroxides, whilst amalgams of Cd, Sn, Sb, Fe, Al, Cr, Mn, Zn, Ni, Co, Ti, V, Zr, Th, La, Ce, Nd, Pr, Mg, and U decompose in the inner compartment, giving hydroxides. The amalgams of the metals may thus be divided into two classes, and it becomes possible to separate metals of the first class from those of the second. T. H. P.

348. *Electrolytic Production of Glycolic Acid.* (U.S. Pat. 887,083. Electrochem. Ind., N.Y. 5. p. 415, Oct., 1907. Abstract.)—O. Liebnecht, of the Roessler and Hasslacher Chemical Co., reduces oxalic acid almost quantitatively to glycolic acid by using a diaphragm cell with a kathode (Pb) characterised by high supertension. 700 parts of crystallised oxalic acid are dissolved in 3,300 parts of water and 1,100 parts of 30 per cent. sulphuric acid; the electrolyte is stirred and kept warm. The anode solution is sulphuric acid of 30 per cent., the current density 25 to 250 amps./m.^{2} of kathode. The sulphuric acid of the kathode solution is finally neutralised with lime, the last traces of which are precipitated with oxalic acid, and the old anode acid is used for preparing new kathode solutions. The sulphuric acid may be replaced by 20 per cent. hydrochloric acid; this latter acid need only be evaporated to gain the glycolic acid. H. B.

349. *Electrolysis of the Halides of the Alkaline Earth Metals.* **H. S. Lukens and E. F. Smith.** (Amer. Chem. Soc., Journ. 29. pp. 1455–1460, Oct., 1907. Contribution from the John Harrison Lab. of Chemistry.)—When magnesium chloride is electrolysed by means of Hildebrand's apparatus [Abstract No. 1266 (1907)], the metal forms a mass of hydroxide in the inner vessel, and the same is the case with calcium chloride if Mg is present. Barium and strontium, on the other hand, behave like the alkali metals, not being effected by the presence of Mg. Separations were made of the alkali and alkaline earth metals from Fe and Al. T. H. P.

350. *Electrolysis of Metallic Chloride Solutions with the use of Rotating Silver Anode and Mercury Kathode.* **T. P. McCutcheon, Jr., and E. F. Smith.** (Amer. Chem. Soc., Journ. 29. pp. 1460–1464, Oct., 1907. Contribution from the John Harrison Lab. of Chemistry.)—The author gives results of the electrolysis of solutions, containing about 0·1 gm. of metal per 0 c.cm of the chlorides of Ce, La, Nd, Pr, Zr, Ti, Yt, Th, U, Fe, Al, Cr, Sn, Zn, Ni, and Cu. The Hildebrand cell was employed, the anode making 200 r.p.m., and the voltage being usually 8. With chlorides of the sesquioxide type, stable colloidal solutions of the hydroxides are formed, whilst with chlorides corresponding with dioxides or protoxides such colloids are either not formed or, if formed, are extremely unstable. T. H. P.

351. *Electrolytic Preparation of Disulphides.* Part I. *Dibenzyl Disulphide and Diethyl Disulphide.* **T. S. Price** and **D. F. Twiss.** (Chem. Soc., Journ. 91. pp. 2021–2031, Dec., 1907.)—By electrolysing aqueous solutions of sodium benzyl thiosulphate and sodium ethyl thiosulphate, in the presence of sodium carbonate, dibenzyl and diethyl disulphides, free from mercaptan, are respectively obtained. The solution should be heated to 60–70° C., and 50 per cent. more than the theoretical current passed, using a kathode current of about 1 amp./dm.^{2}. The electrolysis may be carried out in a beaker, the kathode consisting of a sheet of Pt-foil, and the anode—at which the disulphides are formed—of a stout Pt-wire. Instead of pure sodium benzyl thiosulphate, the mixture produced by heating together an alcoholic solution of benzyl chloride and aqueous sodium thiosulphate may be directly electrolysed, but a divided cell must then be employed. Diethyl disulphide may be also prepared by electrolysing the product yielded by the interaction of ethyl iodide and sodium thiosulphate. The results obtained support the constitutional formula $NaO.SO_2.SNa$, assigned to sodium thiosulphate by Bunte. W. H. Si.

REFERENCES.

352. *Diffusion of Salts in Solution. II.* **J. C. Graham.** (Zeitschr. Phys. Chem. 59. pp. 691–696, July 16, 1907. Translation.)—A continuation of previous work [see Abstract No. 2029 (1904)]. The paper is not suitable for abstraction. F. J. B.

353. *Amorphous Sulphur.* **F. Hoffmann** and **R. Rothe.** (Zeitschr. Phys. Chem. 59. pp. 448–450, June 11, 1907.)—Smith and Carson have now brought their conclusions [Abstract No. 1763 (1907)] into line with those of the present authors, who here point out that this is a complete change of front as compared with Smith, Holmes, and Hall's former view [Abstract No. 1946 (1905)]. L. H. W.

354. *Optical Rotary Power of Liquid Ammonia, Methylamine, and Sulphur Dioxide Solutions.* **R. H. Sherry.** (Journ. Phys. Chem. 11. pp. 559–568, Oct., 1907.)

355. *Solubility of Potassium Iodide in Water and of Water in Potassium Iodide at Low Temperatures.* **R. Kremann** and **F. Kerschbaum.** (Zeitschr. Anorg. Chem. 56. 2. pp. 218–222, Nov. 25, 1907. Chem. Inst. d. Univ., Graz.)

356. *Osmotic Pressure of Compressible Solutions.* **A. W. Porter.** (Roy. Soc., Proc. Ser. A. 79. pp. 519–528, Sept. 6, 1907.)—An exact equation is given connecting the osmotic pressure and vapour pressure of solutions of any concentration, of any degree of compressibility, and under any hydrostatic pressure; the equation is therefore applicable even in the neighbourhood of the critical point. Exact equations are also given showing the dependence of osmotic pressure and vapour pressure on hydrostatic pressure. T. M. L.

357. *Concerning Battelli and Stefanini's Note on "The Relation between Osmotic Pressure and Surface Tension."* **A. Sella.** (Accad. Lincei, Atti, 16. pp. 384–385, Sept. 15, 1907.)—The author questions the validity of the theoretical demonstration by which Battelli and Stefanini have sought to establish the proposition that those solutions which have the same surface tension should be iso-osmotic. [See Abstract No. 1116 (1907).] D. H. J.

358. *Fusibility of Mixtures of Thallium with Sulphur, Selenium, and Tellurium.* **H. Pélabon.** (Comptes Rendus, 145. pp. 118–121, July 8, 1907.) W. H. Si.

359. *Manganese in Cast Iron.* **H. E. Field.** (Mech. Eng. 20. pp. 272–273, Aug. 24, 1907. Paper read before the Amer. Foundrymen's Assoc., May, 1907.)—Endeavours to reconcile the different conclusions reached by various workers. Instances are given showing, as is known, that Mn and sulphur tend to segregate towards the top of an iron casting. By thus partially removing sulphur, the brittleness due to excessive sulphur is diminished. F. R.

360. *Conductivity of Electrolytes in Aqueous Solutions of Gelatine.* **A. Dumanski.** (Zeitschr. Phys. Chem. 60. pp. 553–562, Oct. 1, 1907.)—The specific conductivity of salts in aqueous solutions is diminished by the addition of gelatine. The diminution is very similar in the different cases and appears to be analogous to the decrease which results from the addition of alcohol or acetone. T. M. L.

361. *Stability of Hydrates as indicated by Equilibrium Curves.* **A. Findlay.** (Faraday Soc., Trans. 3. pp. 153–157; Discussion, pp. 158–163, Oct., 1907. Electrician, 59. p. 599, with Discussion, July 26, 1907. Abstract.)

362. *Degree of Dissociation of Compounds which Dissociate on Melting.* **R. Kremann.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2b. pp. 821–828, May, 1907. From the Chem. Inst. d. Univ., Graz.)—The author determined the degree of dissociation of the phenol aniline compound and phenol picrate from the form of the melting-point curves, when additions of an inert substance were made, and applies van Laar's formula for the dissociation of substances upon melting. The paper is unsuitable for abstracting. F. J. B.

363. *Normal Potential of Au˙ Ions.* **F. H. Campbell.** (Faraday Soc., Trans. 3. pp. 103–113; Discussion, pp. 113–114, Oct., 1907. Chem. News, 96. pp. 15–17, July 12, and pp. 25–27, July 19, 1907.)—The normal potential of Au˙ ions compared with the hydrogen standard is found to have the limiting value—

$$\varepsilon_h \mathrm{Au}_{metal}/1n\mathrm{Au}^{\cdot} = +1{\cdot}5 \text{ volts above hydrogen standard.}$$ L. H. W.

364. *A Relation between the* k-*Values of Saline Solutions.* **E. van der Ven.** (Archiv. Musée Teyler, 11. 1. pp. 115–139, 1907.)—A description is given of a series of conductivity measurements made by measuring the p.d. between the inner and outer surfaces of a porous pot filled with the solution when a constant current was allowed to flow. The porosity of the pots was determined by the rate of leakage of distilled water through them. T. M. L.

365. *Effect of Acetone on the Transport Numbers of Sodium and Potassium Chlorides in Aqueous Solutions.* **H. F. Lewis.** (Journ. Phys. Chem. 11. pp. 569–578, Oct., 1907.)